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On two *Heptathela* species from southern Vietnam, with a discussion of copulatory organs and systematics of the Liphistiidae (Araneae: Mesothelae)

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On two *Heptathela* species from southern Vietnam, with a discussion of copulatory organs and systematics of the Liphistiidae (Araneae: Mesothelae). - *Songthela australis* Ono, 2002 is re-defined on the basis of new material from the type locality and from a second locality nearby. The male of this species is described for the first time. A closely related species, *Heptathela nui* sp. n., is described from males and females collected at two other localities in the same province. Variation in the copulatory organs of both species is illustrated and notes are given on their biology, particularly on their association with an ectoparasitic mite species of the genus *Ljunghia* Oudemans, 1932. "Twig-lining" is reported for one population of *H. nui* sp. n. *Songthela australis* and *H. nui* sp. n. are compared with *Nanthela tonkinensis* (Bristowe in Bristowe & Millot, 1933) and *H. tomokunii* Ono, 1997a from northern Vietnam, with *H. kimurai* (Kishida, 1920), *H. kikuyai* Ono, 1998, *Ryuthela owadai* Ono, 1997b and *R. nishihirai* (Haupt, 1979) from Japan, and with *Liphistius ornatus* Ono & Schwendinger, 1990 and *L. thaleri* Schwendinger, 2009 from Thailand. Additional taxonomic characters are illustrated for most of these species. Judging from apomorphies in the male copulatory organs, *S. australis* and *H. nui* sp. n. are sister species, but their female copulatory organs are very different. This challenges the generic concepts of *Songthela* Ono, 2000 and *Abcathela* Ono, 2000 (the latter earlier placed in the synonymy of *Heptathela*). The genus *Nanthela* Haupt, 2003 has no clear apomorphies, and transitions of diagnostic characters between *Nanthela*, *Songthela* and *Heptathela* were found. Thus *Nanthela* and *Songthela* are here placed in the synonymy of *Heptathela*. Morphology and conflicting terminology of copulatory organs in Liphistiidae, and the current confusion in Heptathelinae systematics are discussed. The copulatory organs of males and females of *Liphistius* Schiödte, 1849 and *Ryuthela* Haupt, 1983 are here considered as more derived than those of *Heptathela*. Some observations on moulting of liphistiid spiders are given.

Keywords: Taxonomy - new species - *Liphistius* - *Nanthela* - *Ryuthela* - *Songthela* - *Ljunghia* - Acari.

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INTRODUCTION

The Heptathelinae (considered as a family by Haupt, 2003: 69) is a group of 41 species (including the new one described in here), which are very distinct in their genital morphology from the 49 currently known species of Liphistiinae (all in the genus *Liphistius*) and which are also geographically separated. Heptathelinae occur in eastern Asia, Liphistiinae in southeastern Asia, both ranges roughly divided (but not everywhere; Schwendinger, in preparation) by the river Mekong. Originally only comprising the genus *Heptathela* Kishida, 1923, other genera were added to the Heptathelinae as the number of species increased: *Ryuthela* Haupt, 1983, *Abcathela* Ono, 2000, *Songthela* Ono, 2000, *Vinathela* Ono, 2000, *Nanthela* Haupt, 2003 and *Sinothela* Haupt, 2003. Unfortunately many of the recently added genera were based on characters of a single sex.

The discovery of heptatheline spiders at four localities in Lam Dong Province, including the type locality of *Songthela australis*, by one of us (PJS) in 2003 yielded the previously unknown male of that species and a new, closely related one. With this also came a surprise: the male copulatory organs of both species are very similar, but the female copulatory organs so strongly different that, according to the current system, they would need to be placed in different genera. Thus an examination of additional heptatheline species had to be carried out to re-evaluate the existing generic concepts in this group, and this further revealed serious confusion in the terminology used to describe copulatory organs of liphistiid spiders in the literature.

MATERIAL AND METHODS

External morphology was studied and drawn with a Zeiss SV11 stereomicroscope, the vulvae (tissue removed with forceps) with a Nikon Optiphot compound microscope (both with a drawing tube). SEM micrographs were taken with a Zeiss DSM-940A scanning electron microscope; prosoma photos were taken at several focal planes with a digital camera on a Leica MZ APO stereomicroscope and assembled with the AutoMontage® system. Hairs were partly or completely omitted in the drawings of the male palp. Body measurements were taken with a stereomicroscope and are given in mm. The total body length includes the chelicerae. The carapace length was measured in a slightly forward-inclined position, with the anterior and the posterior margins at the same focal plane. Lengths of leg articles and palpal articles were measured on the dorsal side, from midpoint of anterior margin to midpoint of posterior margin, and are given in the following order: total (femur + patella + tibia + metatarsus + tarsus).

Terminology of the copulatory organs in Heptathelinae largely follows Song & Haupt (1984), but what they called "receptacles" (other authors called them bursae) are here called "receptacular clusters" (except for the *H. tomokunii* females examined). The term "genital plate" is inappropriate for Heptathelinae because that refers to the ventral wall of the genital atrium plus the entire bursa copulatrix with its dorsal and ventral walls, all of which are unsclerotised. "Slerotised" refers to areas in the cuticle that are hard, stiff and strongly pigmented; "unsclerotised" refers to cuticular structures that are thin and unpigmented or thick and moderately pigmented (as is the bursa copulatrix) but that are always flexible. We use "cymbial projection" as a shorter form of Haupt's (2003: 69) "distal projection on the ventral side (of the cymbium)", which

can also be described as the "elongate proventral-distal lobe of the cymbium". "Carapace" is used instead of "dorsal plate of prosoma". The informal appellation "allotype" refers to the paratype on which the description of the female of the new species is based. Positioning (dorsal, ventral, etc.) on the palpal organ refers to an unexpanded, outstretched palp. In the following text generic names, which are currently in synonymy or which are here placed in synonymy, are given between inverted commas.

Abbreviations not explained in the figure legends are: AME, ALE, PME, PLE = anterior (posterior) median (lateral) eyes; IEBR = Institute of Ecology and Biological Resources of the Vietnamese Academy of Science and Technology, Hanoi, Vietnam; MHNG = Muséum d'histoire naturelle de la Ville de Genève, Switzerland; MOQ = median ocular quadrangle; MNHN = Muséum national d'Histoire naturelle, Paris, France; NSMT = National Museum of Nature and Science (formerly National Science Museum), Tokyo, Japan.

TAXONOMY

Liphistiidae Thorell, 1869

Heptathelinae Kishida, 1923

Heptathela Kishida, 1923

Abcathela Ono, 2000; type species *Heptathela abca* Ono, 1999; placed in the synonymy of *Heptathela* by Haupt, 2003: 71, 79.

Nanthela Haupt, 2003; type species *Liphistius tonkinensis* Bristowe in Bristowe & Millot, 1933; **syn. n.**

Sinothela Haupt, 2003; type species *Heptathela sinensis* Bishop & Crosby, 1932; placed in the synonymy of *Songthela* by Platnick, 2011 (in an earlier version of that online catalogue); **syn. n.**

Songthela Ono, 2000; type species *Heptathela hangzhouensis* Chen, Zhang & Zhu, 1981; placed in the synonymy of *Sinothela* by Haupt, 2003: 71; **syn. n.**

Vinathela Ono, 2000; type species *Heptathela cucphuongensis* Ono, 1999; placed in the synonymy of *Heptathela* by Haupt, 2003: 71, 79.

TYPE SPECIES: *Liphistius kimurai* Kishida, 1920.

EMENDED DIAGNOSIS: Distinguished from *Ryuthela* Haupt, 1983 by males possessing a conductor on sclerite III of the palpal organ and lacking an enlarged denticle (= contrategular spine) on its sclerite II; females with 2, 3 or 4 receptacles or receptacular clusters on the anterior margin of the bursa copulatrix (if 2, then these more widely separated from each other than in *Ryuthela*), or with 2 anteriorly and 2 dorsally on the bursa, or with 2 anteroventrally and 2 anterodorsally. Distinguished from *Liphistius* Schiödte, 1849 by the presence of 7-8 spinnerets (posterior medians more or less distinctly fused) and by the lack of clavate trichobothria on tarsi of legs and palps; males without retrolateral tibial apophysis on palp, palpal organ with large tegulum carrying two prominent apophyses, contrategulum and subtegulum without apophyses, paracymbium without cumulus; females with leathery but unsclerotised walls of the bursa copulatrix devoid of thickened rim and vesicles, gland pores usually restricted to receptacles or receptacular clusters situated anteriorly, dorsally or only slightly anteroventrally on the bursa.

The two species from southern Vietnam

Heptathela australis (Ono, 2002) Figs 1-20, 55-58, 67

Songthela australis Ono, 2002a: 120-122, figs 1-8 (description of female).
Heptathela australis (Ono, 2002).- Platnick, 2011 (transferred without explanation in an earlier version of that online catalogue; this generic placement is maintained here).

Material examined: NSMT-Ar 9617 (1 male), IEBR, without registration numbers (1 male and 1 female), MHNG, without registration numbers (all other specimens), sample SV-03/18; 9 males (matured early June 2004, 2.VII.2004, 30.VII.2004, 30.VI.2006, 10.V.2007, 24.V.2007, May 2007, 17.IV.2008, 27.IV.2008), 10 females and 1 juvenile; near Dambri Waterfall, about 18 km N of Bao Loc, 11°38'42"N, 107°44'37"E, 850 m; 1.-2.IX.2003; leg. P. J. Schwendinger. – MHNG, without registration number, sample SV-03/17; 1 male; Lam Dong Province, off the road from Da Hoa (= Da Huoai) to Bao Loc, about 13 km SW of Bao Loc, 11°27'20"N, 107°43'04"E, 690 m; 31.VIII.2003; leg. P. J. Schwendinger.

Emended diagnosis: Males of *H. australis* differ from those of *H. tonkinensis* by a narrower cymbium with a longer and narrower elongate proventral-distal projection; paracymbium much longer and basally much narrower, almost forming a right angle with the cymbium; an unpigmented and unsclerotised zone present distoventrally on cymbium; marginal tegular apophysis much longer and pointed, terminal tegular apophysis with its dorsal edge much less projecting and less dentate; contrategulum with two distal edges running parallel to each other: an outer sharp edge and an inner dentate edge; the sharp edge with a pronounced, beak-like extension prolaterally, the dentate edge not connected with the isolated denticles in the ventro-proximal part of the contrategulum; conductor shorter, situated close to the embolus, its apex without denticles; embolus longer. Females of *H. australis* are similar to those of *H. hangzhouensis*, differing by larger posterior "bursae" (= receptacular clusters) (see Ono, 2002a: 120, referring to Song & Haupt, 1984: fig. 3c-d). Another distinction is found in the shape of the bursa copulatrix in dorsal and ventral view: longer and trapezoidal or triangular in *H. australis*, shorter and rectangular in *H. hangzhouensis*.

Description of male (matured 10.V.2007): Colouration in alcohol (live specimens distinctly darker): Ground colour of carapace light brown, with indistinct dark brown W-shaped pattern behind dark ocular mound and with dark brown band along anterior and lateral margins. Opisthosoma cream, mottled with light grey; tergites uniformly light greyish brown; sternites light orange-brown; spinnerets cream. Chelicerae light brown distally, cream proximally. Legs and palps dorsally uniformly light reddish brown except for a dark red-brown distal zone of the cymbium (not including cymbial projection); no dark annulation present. Ventral side of body and limbs generally lighter than dorsal side.

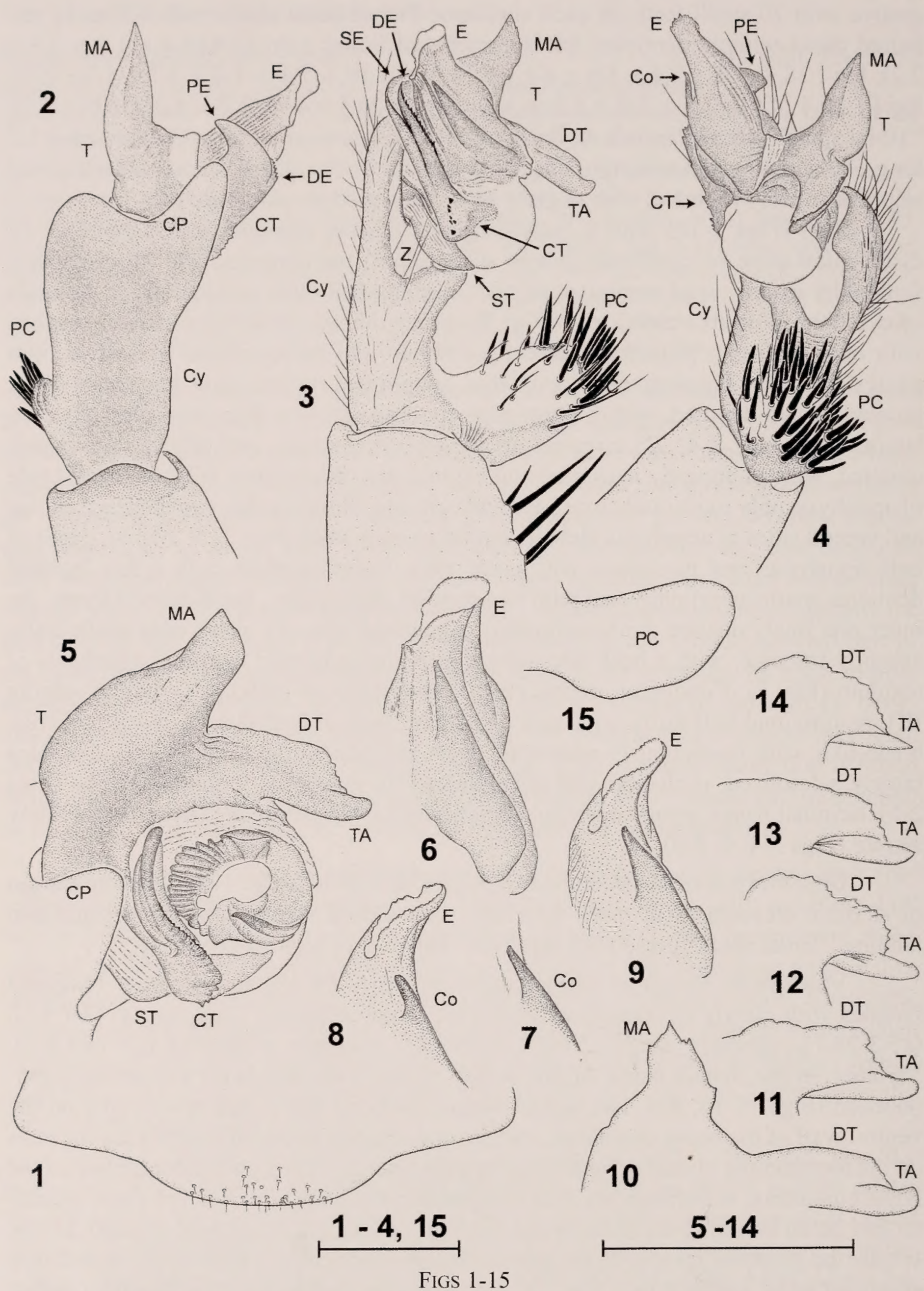
Total length 15.2. Carapace 6.4 long, 5.2 wide, set with a few short, peg-like hairs (with blunt tips) on margin (mostly anteriorly and posteriorly), behind ocular mound and on coxal elevations, only few longer pointed hairs running over ocular mound in a longitudinal row. Eye group 0.92 long, 1.05 wide. Eye sizes and interdistances: AME 0.04, ALE 0.59, PME 0.30, PLE 0.53; AME-AME 0.09, AME-ALE 1.14, PME-PME 0.04, PME-PLE 0.12, ALE-PLE 0.08. MOQ 0.43 long, front width 0.19, back width 0.46. Labium 0.4 long, 1.2 wide. Sternum 2.5 long, 2.2 wide (1.2 on ventral surface). Anterior margin of sternum distinctly elevated, thus a deep suture present between sternum and labium. Maxillae 2.2 long, 1.4 wide. Promargin of cheliceral

groove with 10 small teeth on each chelicera. Paired tarsal claws with 4-5 teeth; unpaired claws without denticles. Measurements of limbs: palp 11.4 (3.4 + 1.9 + 3.9 + 2.2); leg I 18.7 (5.1 + 2.4 + 3.8 + 4.9 + 2.5); leg II 19.1 (5.0 + 2.4 + 3.7 + 5.3 + 2.7); leg III 20.4 (4.9 + 2.5 + 3.8 + 6.2 + 3.0); leg IV 26.5 (6.5 + 2.7 + 5.0 + 8.6 + 3.7). "Tibial spurs" (sensu Platnick & Goloboff, 1985) absent on all legs. Opisthosoma 5.7 long, 3.6 wide; posterior margin of genital sternite (= sternite of second opisthosomal segment) widely rounded, with slightly protruding median part (Fig. 1).

Palp (Figs 2-15) with a quite long and narrow cymbial projection (Fig. 2); distoventral zone of cymbium (below subtegulum) unpigmented and unsclerotised, formed by extension of unpigmented and unsclerotised inner (retrolateral distal) side of cymbium onto its ventral side (Fig. 3); paracymbium relatively long and narrow, with only indistinct proximal tubercle; cymbium and paracymbium almost at right angles (Fig. 3). Tegulum with two large apophyses: 1) marginal apophysis long, pointed, distad-directed, with a sharp edge running across it from prolateral to retrolateral side (Figs 2-4); 2) terminal apophysis retrolaterad- and slightly proximad-directed, with an abruptly narrowed and slightly distad-bent apex (Fig. 3), dorsal side of apophysis only moderately extended and carrying a low, weakly dentate edge, dorsal and ventral sides of apophysis almost parallel to each other (Figs 3, 5, 10-14); edges of both apophyses not in contact with each other. Contrategulum with a few isolated denticles ventro-proximally and with two parallel distal edges, the outer one sharp, the inner one finely dentate, both uniformely pigmented (Fig. 3); sharp edge prolaterally abruptly truncate, with a beak-like extension pointing toward marginal apophysis of tegulum (Fig. 2). Conductor arising ventro-proximally on embolus (= bulbal sclerite III), its proximal half fairly wide and fused with base of embolus, its distal half free, blade-like, with continuously narrowing sides and pointed apex (Figs 3-9). Embolus largely sclerotised, prolateral half strengthened by numerous longitudinal ribs (Figs 2-5); terminal fringe around opening of sperm duct (= spermophore) hyaline and finely serrate (Figs 3-4, 6, 8-9).

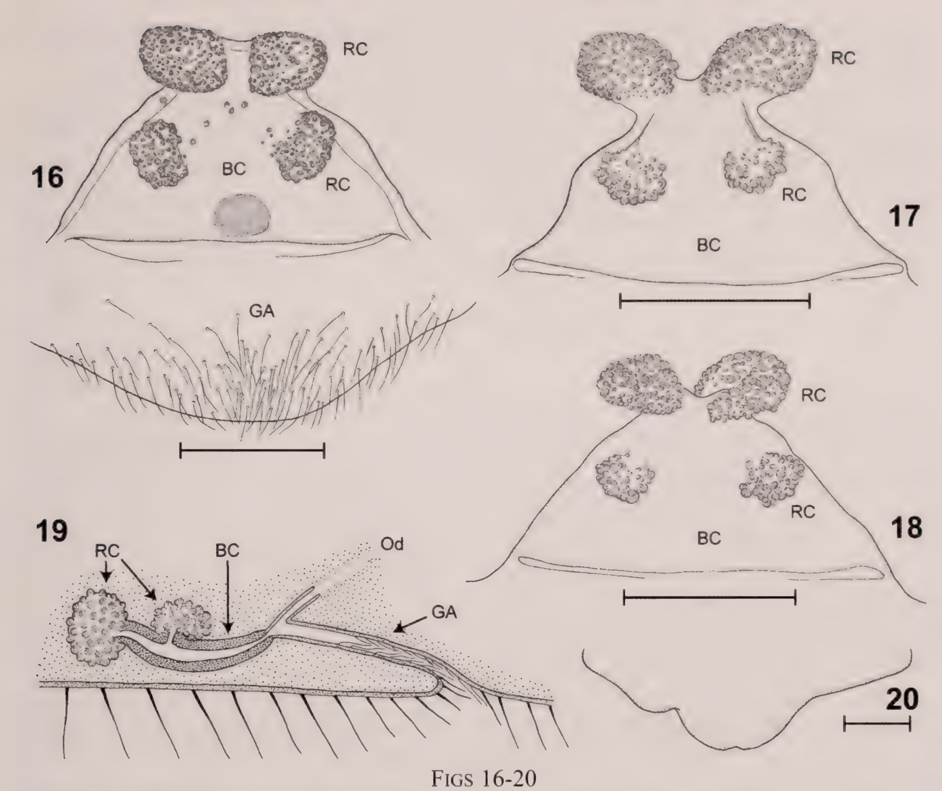
DESCRIPTION OF FEMALE: See Ono (2002a: 120-122, figs 1-8). Anterior margin of sternum elevated as in male, thus also with a deep suture between sternum and labium. "Tibial spurs" present on legs I-III. Vulva as in Figs 16-19, 55-58.

VARIATION: Range of measurements in males (n=10) and in newly collected females with clearly developed vulva (n=10; in parentheses): body length 12.7-17.6 (15.3-24.1), carapace length 5.4-7.1 (6.0-9.4), carapace width 4.2-6.2 (4.8-8.1). Variation in the overall shape of the vulvae of four new females is not strongly pronounced (Figs 16-18, 55). The largest female (only it) has a dark brown spot on the ventral wall of the bursa copulatrix, and several small sclerotised vesicles (as the ones on the receptacular clusters), penetrated by gland pores, sitting on the dorsal wall of the bursa copulatrix, in between the four receptacular clusters (Fig. 16). The latter character can be an atavism (see Discussion: evolution of female copulatory organs). In one female the posterior margin of the genital sternite is indented (probably from an injury sustained in an earlier instar; Fig. 20). For variation in the shape of the palpal organ, see Figs 6-9 (conductor), Figs 3, 10 (marginal tegular apophysis) and Figs 5, 10-14 (terminal tegular apophysis). One male has a proximally narrow paracymbium (Fig. 15). The number of isolated denticles ventro-proximally on the contrategulum varies from 2-7.



Figs 1-15

Heptathela australis (Ono, 2002), male (mature 10.V.2007) from the type locality (1-6), five other males from the type locality (7, 11; 9; 10; 12; 13), male from Dao Hoa - Bao Loc (8, 14-15). (1) Posterior margin of genital sternite, ventral view. (2) Distal part of left palp, prolateral view. (3) Same, ventral view. (4) Same, retrolateral view. (5) Same, distal view. (6, 8-9) Embolus and conductor, proventral view. (7) Conductor, proventral view. (10) Marginal and terminal apo-



FIGS 16-20

Heptathela australis (Ono, 2002). (16) Vulva of largest female, dorsal view; dorsal and lateral walls of genital atrium not shown. (17-18) Bursae copulatrices of two other females, dorsal view. (19) Schema of vulva, lateral view (the oviduct is actually anterodorsad- and not posterodorsad-directed). (20) Posterior margin of deformed genital sternite, ventral view. BC = bursa copulatrix; GA= genital atrium; Od = oviduct; RC = receptacular cluster. Scale lines 1.0 mm.

RELATIONSHIPS: Despite pronounced differences in female copulatory organs, *H. australis* appears most closely related to *N. nui* sp. n. Their palps share distinct synapomorphies, and both species occur in the same mountain range, about 80 km apart. Their closest known relatives are *H. tonkinensis* and *H. tomokunii* from northern Vietnam, but more closely related species most likely await discovery in the mountains between Da Lat and Hanoi. The male of the geographically closer *H. cucphuongensis* (from south of Hanoi) is unknown and therefore the relationships of this species are not yet clear.

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physis of tegulum, ventral view. (11-14) Terminal apophysis of tegulum, ventral view. (15) Outline of paracymbium, ventral view. Co = conductor; CP = cymbial projection; CT = contrategulum; Cy = cymbium; DE = dentate distal edge of contrategulum; DT = dorsal extension of terminal apophysis of tegulum; E = embolus; MA = marginal apophysis of tegulum; PC = paracymbium; PE = prolateral extension of sharp distal edge of contrategulum; SE = sharp distal edge of contrategulum; ST = subtegulum; T = tegulum; TA = terminal apophysis of tegulum; Z = unpigmented distoventral zone of cymbium. Scale lines 1.0 mm.

DISTRIBUTION: Known only from two localities near Bao Loc village in southern Vietnam.

BIOLOGY: The mature male was discovered when scraping leaf litter from the floor of an evergreen broadleaf forest. He probably had left his burrow in search of females and was taking temporary shelter in the leaf litter during the day. All other spiders were extracted from their burrows in sun-exposed earth banks (with little vegetation) on one side of a dirt road in an old secondary forest. None of the burrows inspected at the beginning of September contained mature males, and by then the mating period was probably at its end.

All burrows were closed with a single trapdoor that had its hinge on the upper side of the entrance; the lower rim of the burrow entrance was slightly protruding. Trapdoors of females were up to 3.3 cm wide and 2.5 cm long; those of penultimate males 2.0-2.3 and 1.5-1.8 cm, respectively. No spiders were seen when their doors were carefully opened with forceps for inspection. They were resting in the depth of their burrows and could not be provoked to come to the entrance by inserting a flexible grass stem and disturbing them (which often works for extracting spiders of the genus *Liphistius*). All these spiders had to be dug up. Large and medium-sized spiders (including adult males) react to disturbance by repeatedly raising their body above the ground while the leg tarsi remained on the ground (a behaviour called "tiptoeing") and by spreading their chelicerae, as large *Liphistius* also do. Four egg cases (2.5-3.5 cm in diameter and 1.4-1.9 cm high) were built between the end of November and late December 2003. Three of them held clusters of 129-164 beige or light yellow eggs wrapped in a thin skin made of a coagulated vulval secretion and some fine silken threads (as present in all liphistiid egg cases examined, but less distinct in *Liphistius*), resting on a mesh of fine threads above the bottom of the inner chamber of the egg case. Ninety-nine third (or later?) instar juveniles were taken from the fourth egg case in mid-April 2004. Five of them were males that reached maturity in June 2006, May 2007 and April 2008, which is presumably earlier in the year than in nature (since the adult male was found at the end of August). Development from eggs to adult males in captivity thus took between one and a half years and three years and four months. Females which laid eggs between November and December moulted in the following March, May and June.

Three of the large females, which were collected in the field and subsequently laid eggs in Geneva, each carried more than 50 ectoparasitic mites of different instars on their prosoma. These mites were usually sitting on the carapace, but when disturbed took shelter on the ventral side, between the coxae and the sternum, and between the prosoma and the opisthosoma. They pierced the carapace at numerous places and left clearly visible dark round scars that make the spiders look as if they had measles (Fig. 67). The carapace, a quite strongly sclerotised plate, is an unlikely place for sucking body fluids. Surprisingly, no scars or any other signs of damage are visible on the soft membranes between the sclerites of the prosoma or on the opisthosoma.

Heptathela nui sp. n. Figs 21-33, 68

HOLOTYPE: MHNG, without registration number, sample SV-03/21; male (matured 10.VI.2004); Vietnam, Lam Dong Province, Mt Penhatt near Quang Trung Reservoir, about 8 km SW of Da Lat, 11°52'37"N, 108°25'58"E, 1500 m; 6.IX.2003; leg. P. J. Schwendinger.

PARATYPES: MHNG, without registration number, sample SV-03/21; 2 males (matured 3.V.2004, 10.VII.2004) and 3 females ("allotype" constructed egg case in XII.2003 and moulted 5.IV.2004); collected together with the holotype. – NSMT-Ar 9618, 9619 (1 male, 1 female), IEBR, without registration numbers (1 male, 1 female), MHNG, without registration numbers (all other specimens), sample SV-03/22; 3 males (matured early June 2004, 15.VI.2004, 21.IV.2005) and 4 females; Cam Ly Waterfall, western outskirts of Da Lat city, 11°56'37"N, 108°25'14"E, 1450 m; 8.-9.IX.2003; leg. P. J. Schwendinger.

ETYMOLOGY: "Nui", a noun in apposition, is the Vietnamese word for "mountain".

DIAGNOSIS: Males of the new species can be distinguished from those of the closely related *H. australis* by: anterior margin of sternum low; paracymbium stronger, with distinct proximal tubercle; conductor narrower, with more strongly bent apex; tegulum with larger marginal apophysis, terminal apophysis more continuously narrowing towards apex, its dorsal and ventral sides at an acute angle to each other; prolateral side of contrategulum with light-coloured central portion; sharp (outer) distal edge of contrategulum convex, broadly rounded, without beak-like extension; denticles on inner edge of contrategulum running down to ventro-proximal area in a continuous row; embolus shorter, its terminal fringe more coarsely serrate. Females of *H. nui* sp. n. differ from those of *H. australis* by: bursa copulatrix shorter, with more strongly inclined lateral margins; receptacular clusters smaller, with more or less distinct stalks, all four sitting on the anterior margin of the bursa copulatrix.

DESCRIPTION: MALE (holotype). Colouration in alcohol (live specimens distinctly darker): Carapace and legs light reddish brown; ocular mound dark; bulbal sclerites and distal part of cymbium red-brown, cymbial projection light brown. No annulation on legs or dark pattern on carapace and opisthosomal tergites. Ventral side of body and limbs generally lighter than dorsal side. Opisthosoma cream, mottled with light grey; tergites uniformly light greyish brown.

Total length 14.4. Carapace 6.3 long, 5.0 wide, set with a few short, peg-like hairs (with blunt tips) on margin (mostly anteriorly and posteriorly), behind ocular mound and on coxal elevations; only few long pointed hairs running over ocular mound in a longitudinal row. Eye group 0.87 long, 0.99 wide anteriorly, 0.91 posteriorly. Eye sizes and interdistances: AME 0.04, ALE 0.60, PME 0.32, PLE 0.50; AME-AME 0.14, AME-ALE 0.07, PME-PME 0.05, PME-PLE 0.08, ALE-PLE 0.06. MOQ 0.43 long, front width 0.21, back width 0.52. Labium 0.5 long, 1.2 wide. Sternum 2.7 long, 2.2 wide (1.3 on ventral surface). Anterior margin of sternum low, thus only a shallow furrow present between sternum and labium. Maxillae 2.2 long, 1.4 wide. Promargin of cheliceral groove with 10 teeth on right chelicera, 12 on left. Paired tarsal claws with 3-5 teeth; unpaired claws without denticles. Measurements of limbs: palp 12.1 (3.6 + 2.1 + 4.1 + 2.3); leg I 19.7 (5.6 + 2.5 + 4.0 + 5.0 + 2.6); leg II 19.3 (5.2 + 2.4 + 3.8 + 5.2 + 2.7); leg III 20.6 (5.0 + 2.5 + 3.8 + 6.2 + 3.1); leg IV 25.9 (6.6 + 2.7 + 4.9 + 8.2 + 3.5). "Tibial spurs" absent on all legs. Opisthosoma 5.6 long, 3.7 wide; posterior margin of genital sternite widely rounded, with an indistinct invagination in the middle (Fig. 21).

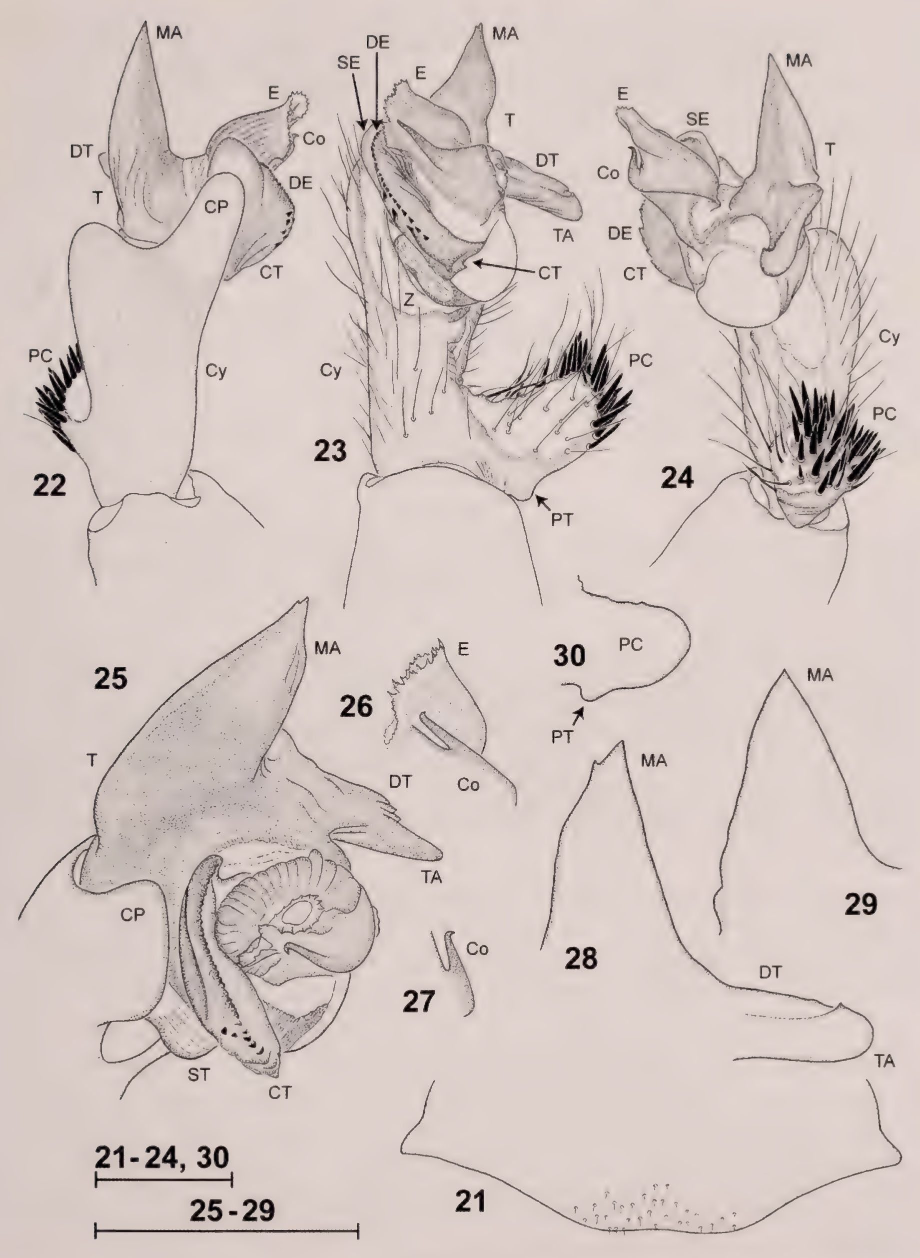
Palp (Figs 22-26) with paracymbium carrying a proximal tubercle (Fig. 23); cymbium and paracymbium almost at right angles to each other; distoventral zone of cymbium (below subtegulum) unpigmented and unsclerotised (Fig. 23). Tegulum with a very long, pointed, distad-directed marginal apophysis with a sharp edge (Figs 22-25), and with a retrolaterad- and slightly proximad-directed terminal apophysis continuously narrowing to a rounded, distad-bent apex (Figs 23, 25); dorsal side of terminal apophysis less extended than in *H. australis*, carrying a weakly dentate edge (Fig. 25) not being in contact with edge on marginal apophysis. Contrategulum with a cream central portion on prolateral side (Fig. 22); two parallel distal edges present: the outer one sharp, the inner one finely dentate (Fig. 23); sharp edge convex, widely rounded, without beak-like extension (Fig. 22); row of denticles on inner edge running down to near ventro-proximal margin of contrategulum and there forming two rows of denticles together with a few irregularly arranged additional denticles situated more proximally (Fig. 23). Conductor situated ventro-proximally on embolus; proximal portion of conductor fairly wide and fused with embolic base; distal portion of conductor free, narrow, blade-like, with slightly hook-like apex (Figs 23-26). Embolus largely sclerotised, prolateral half strengthened by numerous longitudinal ribs (Figs 22, 25); terminal fringe around opening of sperm duct (= spermophore) hyaline, coarsely serrate, with fairly deep indentations (Figs 22-24, 26).

FEMALE ("allotype"). Colouration similar to that of male but slightly lighter; palpal tarsi brown.

Total length 21.6. Carapace 8.3 long, 6.3 wide. Eye group 0.97 long, 1.03 wide anteriorly, 1.00 posteriorly. Eye sizes and interdistances: AME 0.06, ALE 0.60, PME 0.35, PLE 0.50; AME-AME 0.19, AME-ALE 0.14, PME-PME 0.04, PME-PLE 0.06, ALE-PLE 0.06. MOQ 0.49 long, front width 0.30, back width 0.52. Labium 1.1 long, 2.0 wide. Sternum 3.6 long, 2.5 wide (1.9 on ventral surface), its anterior margin distinctly elevated, thus separated from labium by a deep suture (not so in males). Maxillae 2.8 long, 1.9 wide. Promargin of cheliceral groove with 11 teeth on each chelicera. Paired tarsal claws of legs with 2-4 teeth, unpaired claws without denticles; each palpal claw with 2 denticles. Measurements of limbs: palp 13.3 (4.5 + 2.5 + 3.0 + 3.3); leg I 15.2 (4.9 + 2.6 + 3.0 + 3.0 + 1.7); leg II 14.6 (4.4 + 2.6 + 2.7 + 3.1 + 1.8); leg III 15.5 (4.3 + 2.7 + 2.7 + 3.8 + 2.0); leg IV 21.9 (6.1 + 3.0 + 3.9 + 6.2 + 2.7). "Tibial spurs" present on legs I-III. Opisthosoma 7.7 long, 6.4 wide. Posterior margin of genital sternite broadly rounded, with a slight median invagination.

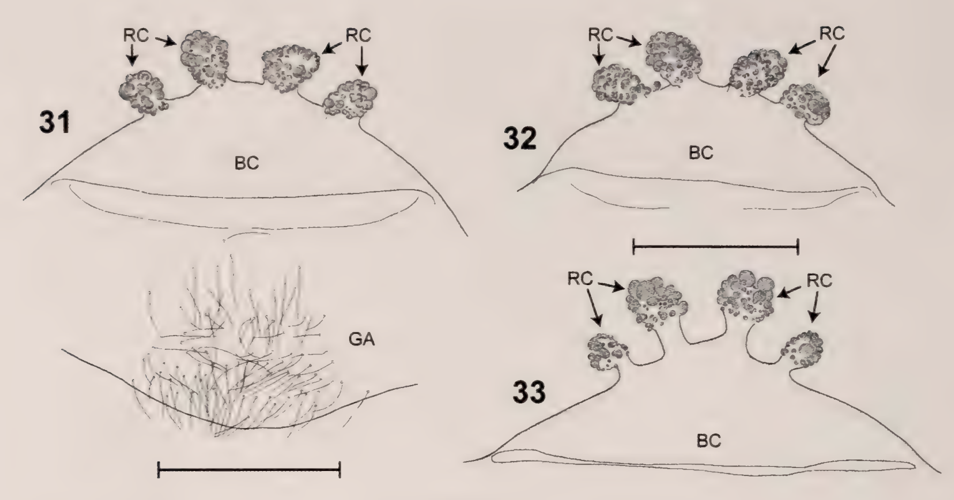
Vulva (Fig. 31). Bursa copulatrix short, plano-convex in dorsal and ventral view, its anterior margin widely rounded and carrying four anteriad-directed receptacular clusters on indistinct short stalks, the median pair slightly larger than the lateral one. Genital atrium densely set with fine hairs on dorsal and ventral walls.

VARIATION: Range of measurements in males (n=6) and in females with clearly developed vulvae (n=7; in parentheses) examined: Body length 13.2-16.5 (16.4-22.5), carapace length 5.2-6.5 (6.1-8.2), carapace width 4.2-5.3 (4.9-6.5). For variation in the shape of the vulva in three females, see Figs 31-33. In one female the receptacular clusters are raised on relatively long stalks (Fig. 33), in two other females the stalks are stout and rather indistinct (Figs 31-32). Variation in the shape of the palpal organ is less pronounced than in *H. australis*: the marginal tegular apophysis carries a subterminal



FIGS 21-30

Heptathela nui sp. n., male holotype (21-26) and three male paratypes from Cam Ly Waterfall (27-28; 29; 30). (21) Posterior margin of genital sternite, ventral view. (22) Distal part of left palp, prolateral view. (23) Same, ventral view. (24) Same, retrolateral view. (25) Same, distal view. (26) Embolus and conductor, proventral view. (27) Conductor, proventral view. (28) Marginal and terminal apophysis of tegulum, ventral view. (29) Marginal apophysis of tegulum, ventral view. (30) Outline of paracymbium, ventral view. PT = proximal tubercle of paracymbium; other abbreviations as in Figs 1-15. Scale lines 1.0 mm.



FIGS 31-33

Heptathela nui sp. n., three female paratypes. (31) Vulva of "allotype", dorsal view; dorsal and lateral walls of genital atrium not shown. (32-33) Bursae copulatrices of two other females, dorsal view. Abbreviations as in Figs 16-20. Scale lines 1.0 mm.

denticle in two males (Figs 25, 28), in others it is bare (Fig. 29); the proximal tubercle of the paracymbium is very distinct in two males (Figs 23, 30), less so in others; in some males the scattered denticles below the continuous row of denticles on the ventro-proximal side of the contrategulum are indistinct. In one female the posterior median spinnerets are fused only along their ental sides but the apices are still free, whereas in all other conspecific spiders examined these spinnerets are completely fused.

REMARKS: The paired leg claws of the "allotype" are inflated, especially on the posterior legs. This is not so in any of the other specimens of both species examined and thus it was probably caused by preservation. Similar rare cases of inflated claws were also observed in alcohol-preserved specimens of mygalomorph spiders.

RELATIONSHIPS: *Heptathela nui* sp. n. possesses a vulva similar to that of *H. abca* from northern Vietnam, and to *H. bristowei* Gertsch, 1967, *H. sinensis* and *H. schensiensis* (Schenkel, 1953) from central China. However, strong similarity and several likely synapomorphies in the male palps of *H. australis* and *H. nui* sp. n. show that these species are the most closely related. See also Discussion - Systematics.

DISTRIBUTION: Known only from two localities near Da Lat city in southern Vietnam.

BIOLOGY: The spiders examined were collected from a steam bank in an evergreen hill forest, from the recess of an earth bank at the side of a path in a pine forest (both at Mt Penhatt), and from an earth bank in a park with pine trees (at Cam Ly Waterfall). Burrows were as those of *H. australis*, but at the Cam Ly site (not so on Mt Penhatt) they all had several grass stems attached to their entrances to enlarge the sensory area. "Twig-lining" is known from individual populations of several species of

mygalomorph trapdoor spiders in Australia, North America and Japan (see Haupt, 1995 for a summary), and it was also reported for *Ryuthela* populations (Haupt, 1983: 286) and for some *H. abca* at the type locality (Ono, 1999: 41, figs 13-14). Trapdoors of females were up to 2.6 cm wide and 2.0 cm long; those of penultimate males 1.6-2.1 and 1.1-1.6 cm, respectively. Large and medium-sized spiders react to disturbance by "tiptoeing", spreading their chelicerae and raising their palps. One egg case (2.5 cm in diameter and 1.7 cm high) was built on 19.XII.2004. It held 83 light yellow eggs suspended above the bottom of the inner chamber. The female with eggs moulted in early April of the following year; other females moulted in January, March, April, September, October and November, usually twice per year. Males (collected in early September 2003) became adult between May and July 2004 and in April 2005.

The largest female (gravid; died before laying its eggs) had about 50 ecto-parasitic mites of the genus *Ljunghia* on its prosoma. These caused the same kind of scars on the carapace of the spider (Fig. 68) as described earlier in this paper for *H. australis*.

SPECIES EXAMINED FOR COMPARISON

Heptathela tonkinensis (Bristowe, 1933) Figs 34-38

Liphistius birmanicus Thorell, 1897.- Simon, 1909: 70-71 (misidentification; description of male).

Liphistius tonkinensis Bristowe in Bristowe & Millot, 1933: 1022, text-fig. 4 (naming of species; illustration of palp of male holotype).- Bristowe, 1976: 4 (listing).

Heptathela tonkinensis (Bristowe, 1933).- Haupt, 1983: 284-285, figs 8a-b, d, 13e (transfer; description and illustration of palp of male holotype); Platnick & Sedgwick, 1984: 3 (transfer).

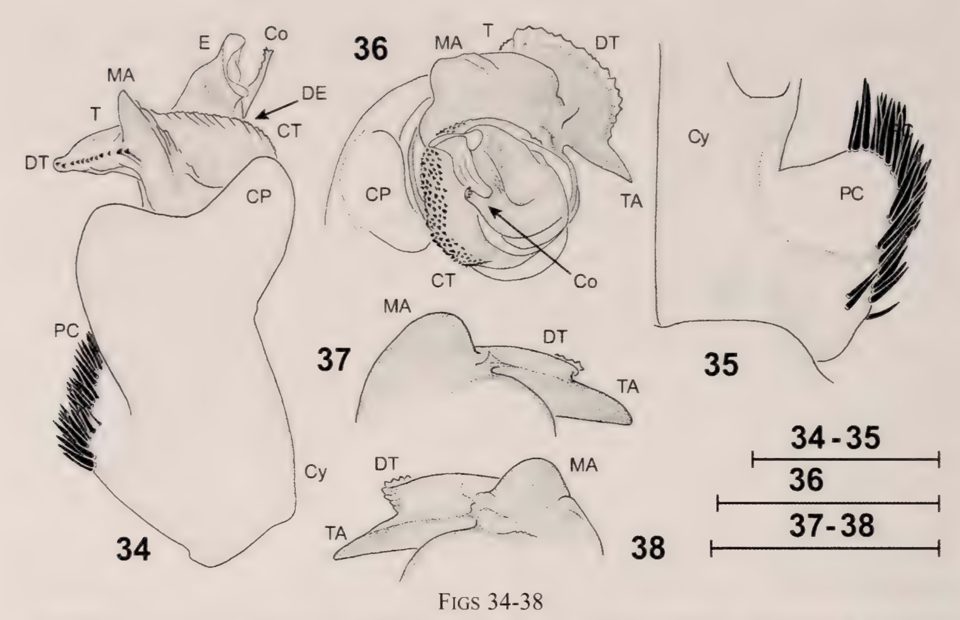
Vinatela tonkinensis (Bristowe, 1933).- Ono, 2000: 150 (transfer).

Nanthela tonkinensis (Bristowe, 1933).- Haupt, 2003: 69, 71, figs 51a-b (transfer; illustration of palp of male holotype).

Here transferred back to *Heptathela*.

MATERIAL EXAMINED: MNHN 29170, AR-4104; male holotype; Vietnam, Tonkin, forêt de Khà là; no collecting date; leg. Blaise.

EMENDED DIAGNOSIS: The previously published descriptions of the holotype do not mention some of the following characters: cymbial projection quite broad and distinctly inclined from axis of cymbium (Fig. 34); distoventral zone of cymbium (below subtegulum) pigmented and sclerotised as normal; paracymbium short and exceptionally wide at base, at an acute angle to axis of cymbium (Fig. 35); contrategulum distally with a broad band of denticles (arranged in several irregular rows) running down to near ventro-proximal margin of contrategulum, no sharp distal edge present (Fig. 36); marginal apophysis of tegulum fairly short, compressed and arched, with a sharp distal edge running from prolateral to retrolateral side (Figs 34, 37-38); terminal apophysis of tegulum beak-like, dorsally with a large and broadly arched extension with a coarsely dentate edge (Figs 34, 36-38) not in contact with edge on marginal apophysis; conductor long (about as long as embolus), its distal part fairly distant from embolus (Figs 34, 36). "Tibial spurs" absent on all legs. Posterior margin of genital sternite widely and uniformly rounded, without protruding median part. Anterior margin of sternum not markedly elevated, suture to labium therefore shallow (as in male of *H. nui* sp. n.).



FIGS 34-38

Heptathela tonkinensis (Bristowe, 1933), male holotype. (34) Distal part of left palp, prolateral view. (35) Paracymbium of left palp, ventral view. (36) Left palpal organ, distal view. (37) Marginal and terminal apophysis of tegulum of left palp, ventral view. (38) Same, right palp. Abbreviations as in Figs 1-15. Scale lines 1.0 mm.

REMARKS: The retrolateral view of the right palp of the holotype given by Bristowe (Bristowe & Millot, 1933: text-fig. 4) is detailed and correct, but it gives the false impression of a quite long and pointed marginal tegular apophysis, as present in *H. australis* and *H. nui* sp. n. A comparison of these three species showed that all of them have a fairly sharp distal edge on their marginal tegular apophysis, and in pro- and retrolateral view this apophysis always looks pointed (see also Fig. 34). Ventral and dorsal views show that in *H. tonkinensis* this apophysis is actually scale-like, fairly short and moderately arched (Figs 37-38; Haupt, 1983: fig 8b; Haupt, 2003: fig. 51B), whereas in *H. australis* and *H. nui* sp. n. it is long, triangular and truly pointed (Figs 3, 5, 10, 23, 25, 28-29).

RELATIONSHIPS: Among the hepthatheline species of which males are known, *H. tonkinensis* currently appears most closely related to *H. tomokunii*; both are more distantly related to *H. australis* and *H. nui* sp. n. *Heptathela cucphuongensis* (known only from females), which also occurs in northern Vietnam (south of Hanoi), is geographically closer and possibly also more closely related to *H. tonkinensis* and *H. tomokunii* than to *H. australis* and *H. nui* sp. n. from the south of the country.

DISTRIBUTION: *Heptathela tonkinensis* is known only from the holotype collected in a forest near Khà là (this spelling is given on the laeser-printed label in the tube with the specimen; in the original description the name of the locality is spelled "Kha-lé"), in the valley of the Song (= river) Luc Nam, northeast of Hanoi (Simon, 1909: 69, 71). This locality probably corresponds to the village of Kha Le, about 15 km east of the township of Luc Nam in Bac Giang Province, northern Vietnam.

Heptathela tomokunii Ono, 1997 Figs 39-43

Heptathela tomokunii Ono, 1997a: 24-26, figs 1-8 (description of male and female).

MATERIAL EXAMINED: NSMT-Ar 3396-3398; male holotype (matured 8.X.1995), female "allotype", 1 female paratype; Vietnam, Vinh Phu Province, Tam Dao, 900 m; 15./21.IX.1995; leg. H. Ono.

REMARKS: Diagnosis and description were given by Ono (1997a). The following can be added: cymbial projection only moderately developed, quite wide (Fig. 39); paracymbium short and wide at base, at an acute angle to axis of cymbium (Ono, 1997a: fig. 2), similar to that of *H. tonkinensis*; subtegulum exceptionally long (Fig. 40); contrategulum with denticles on distal edge modified into a series of parallel ribs running down to 1-2 isolated ventral denticles near proximal margin (Figs 39-40); tegulum with quite low, narrowly arched marginal apophysis and with quite short terminal apophysis (Figs 39, 41) carrying a pronounced, strongly bulging dorsal extension with a coasely dentate edge (Fig. 39; Ono, 1997a: fig. 4) not in contact with edge on marginal apophysis; genital atrium with some hairs on ventral side near posterior and lateral margins (Fig. 42); bursa copulatrix short, anterior margin widely arched; all receptacles simple and smooth [Fig. 43; also confirmed for the "allotype", though the corresponding illustration (Ono, 1997a: fig. 6) indicates indistinctly cauli-flower-shaped receptacles], not developed as caulifower-shaped receptacular clusters as in other Heptathelinae examined; larger lateral pair of receptacles sessile, slightly displaced onto dorsal wall of bursa copulatrix; smaller median pair of receptacles stalked [on common socket in paratype (Fig. 43), on individual stalks in "allotype" (Ono, 1997a: fig. 6)] and slightly displaced onto ventral wall (Fig. 43). "Tibial spurs" present on legs I-III of female, on last exuvia of male and also on mature male (with a few "spurs" reduced).

RELATIONSHIPS: Due to similarities in the palpal organ of males (moderately developed cymbial projection; short, wide paracymbium at an acute angle to the axis of the cymbium; long subtegulum; low, arched marginal tegular apophysis; pronounced dorsal extension of terminal tegular apophysis), *H. tomokunii* appears to be more closely related to *H. tonkinensis* (female unknown) than to *H. australis* and *H. nui* sp. n. More or less pronounced displacements of the lateral pair of receptacles onto the dorsal wall of the bursa copulatrix in *H. tomokunii*, *H. australis* and some *Ryuthela* species are considered homoplasic (see Discussion).

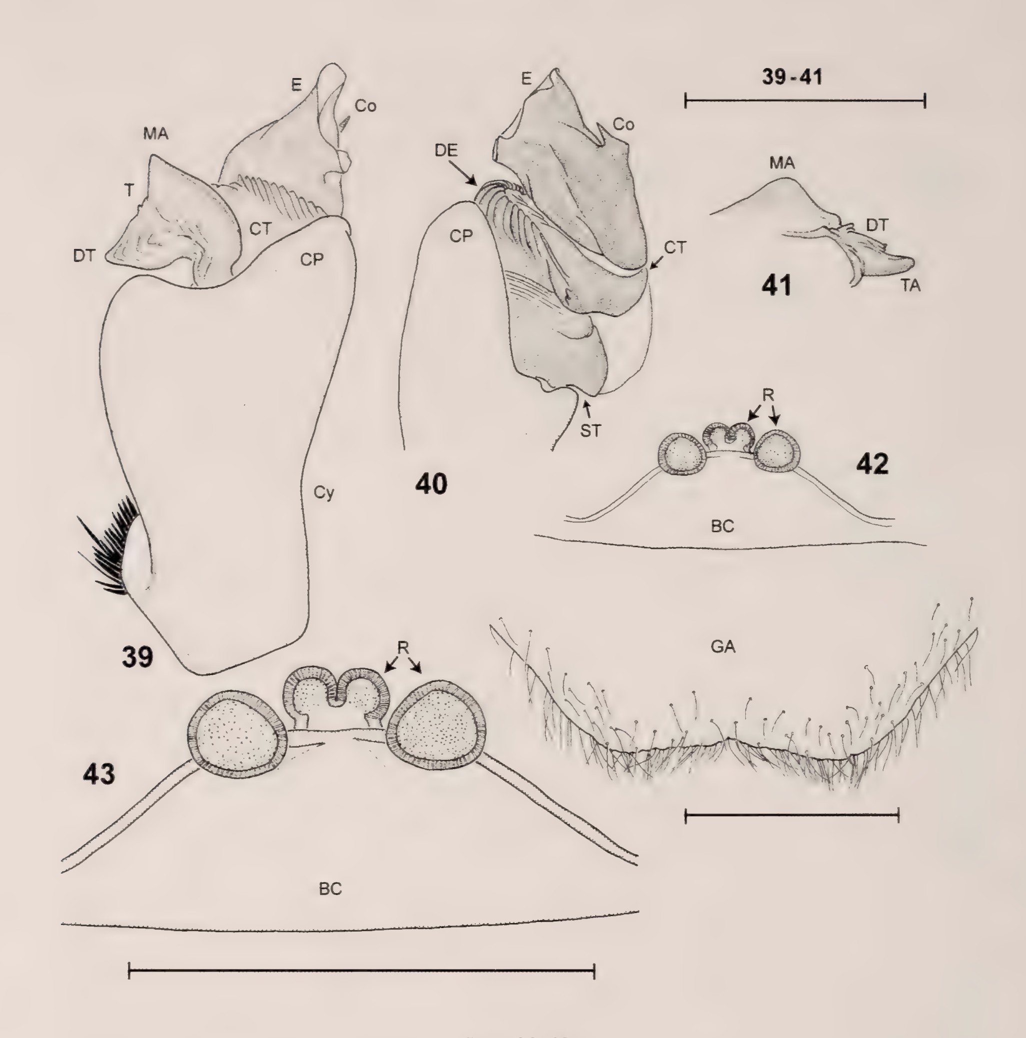
DISTRIBUTION: This species is only known from the type locality, the Tam Dao hill station, about 85 km northwest of Hanoi, in northern Vietnam.

Heptathela kikuyai Ono, 1998 Figs 44-45

Heptathela kikuyai Ono, 1998: 16-19, figs 11-16 (description of male and female).

MATERIAL EXAMINED: NSMT-Ar 8718; 1 male; Japan, Kyushu Island, Oita Prefecture, Hita-shi; 15.X.2006; leg. T. Irie. – NSMT-Ar 3545; 2 females; Kyushu Island, Miyazaki Prefecture, Nishi-ushuki-gun, Takachiho-cho; 8.-14.IX.1996; leg. H. Ono.

DISTRIBUTION: Known from several localities in the northwestern part of Kyushu Island, Japan.



FIGS 39-43

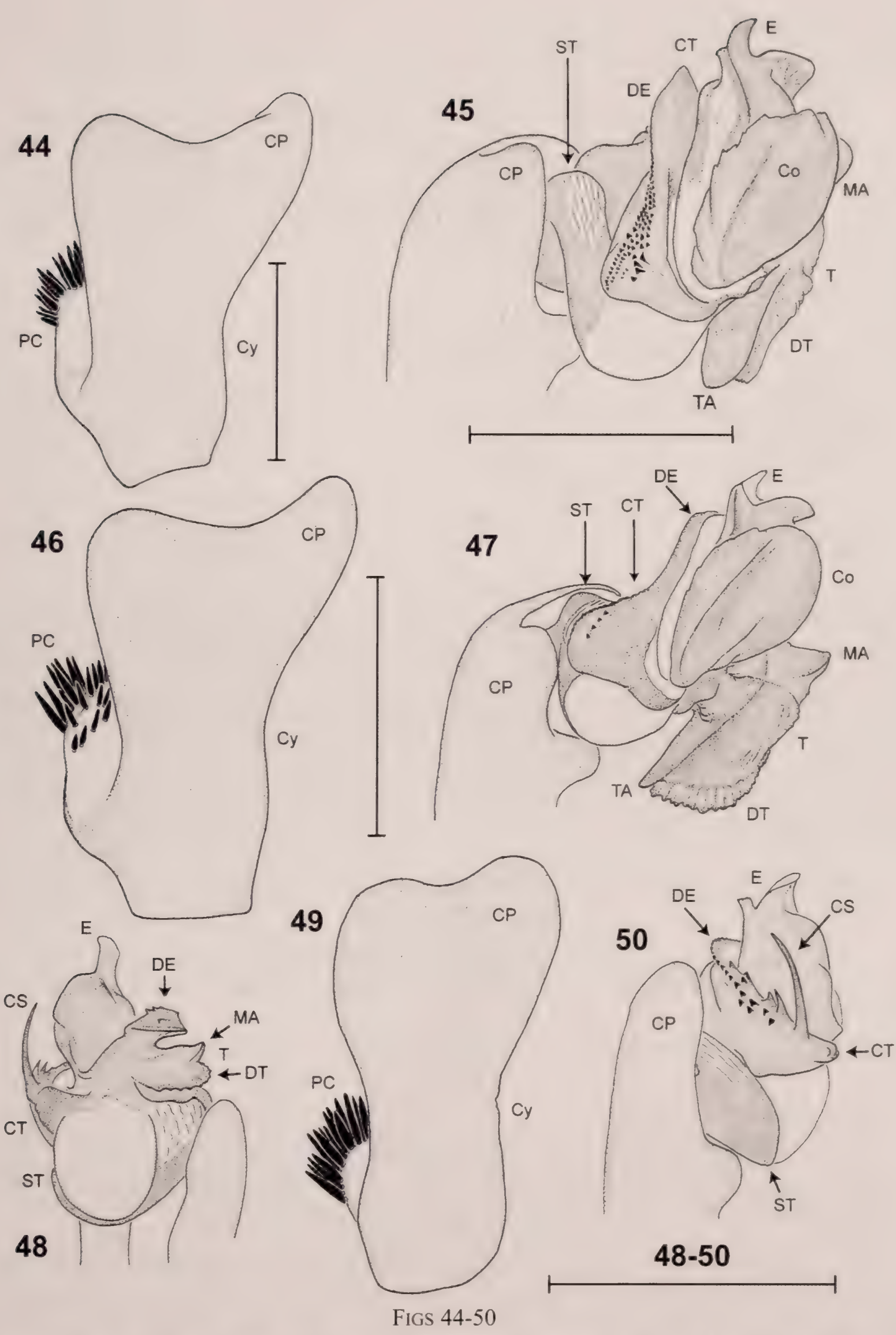
Heptathela tomokunii Ono, 1997, male holotype (39-41) and female paratype (42-43). (39) Distal part of left palp, prolateral view. (40) Left palpal organ, ventral view. (41) Marginal and terminal apophysis of tegulum of left palp, ventral view. (42) Vulva, dorsal view; dorsal and lateral walls of genital atrium not shown. (43) Bursa copulatrix, dorsal view. R= receptacle; other abbreviations as in Figs 1-20. Scale lines 1.0 mm.

Heptathela kimurai (Kishida, 1920) Figs 46-47

Liphistius kimurai Kishida, 1920: 362, fig. 1 (description of male and female); type species of *Heptathela*. For a complete synonymy, see Platnick (2011).

MATERIAL EXAMINED: NSMT-Ar 3549; 1 male; Japan, Kyushu Island, Kagoshima-shi; 7.XI.1970; leg. K. Tanaka. – NSMT-Ar 8717; 1 female; Kyushu Island, Kagoshima-shi, Shiroyama; 25.XI.1997; leg. H. Ono.

DISTRIBUTION: Known from several localities in the southern part of Kyushu Island, Japan.



FIGS 44-50

Heptathela kikuyai Ono, 1998, male (44-45); *Heptathela kimurai* (Kishida, 1920), male (46-47); *Ryuthela owadai* Ono, 1997, male holotype (48-50). (44, 46, 49) Left cymbium, prolateral view. (45, 47, 50) Left palpal organ (45 and 47 slightly expanded), ventral view. (48) Same, retrolateral view. CS = contrategular spine; other abbreviations as in Figs 1-15. Scale lines 1.0 mm.

Ryuthela owadai Ono, 1997 Figs 48-50

Ryuthela owadai Ono, 1997b: 155-157, figs 15-18 (description of male).- Ono, 2001: 151-153, figs 1-3 (description of female).

MATERIAL EXAMINED: NSMT-Ar 3459; male holotype; Japan, Okinawa Prefecture, Tokashiki Island, Aharen, about 100 m; 11.X.1990; leg. M. Owada. – NSMT-Ar 8717; 1 female; Okinawa, Tokashiki Island, Tokashiku, 30 m; 17.I.2001; leg. H. Ono.

DISTRIBUTION: Known only from the Tokashikijima Island, Ryukyu Islands, Japan.

Ryuthela nishihirai (Haupt, 1979)

Heptathela nishihirai Haupt, 1979: 356-362, 365, figs 6-13 (description of male and female); type species of *Ryuthela*. For a complete synonymy, see Platnick (2011).

MATERIAL EXAMINED: NSMT-Ar 422-423; 1 male (matured X.1977) and 1 female syntypes; Japan, Shuri, Okinawa, Ryukyu Islands; 15.III.1976; leg. M. Nishihira & J. Haupt. – MHNG (coll. S. Heimer), without registration number; 1 female; Japan, Ryukyu Islands, without further data.

DISTRIBUTION: Known from several localities on Okinawa Island, Japan.

Liphistiinae Thorell, 1869

Liphistius ornatus Ono & Schwendinger, 1990 Figs 51-54

Liphistius ornatus Ono & Schwendinger, 1990: 166-170, figs 1-8 (description of male and female).

MATERIAL EXAMINED: MHNG, without registration number; male holotype, 1 male paratype, 4 female paratypes; Thailand, Chanthaburi Province, Khao Soi Dao Wildlife Sanctuary, 300-400 m; 9.V.1987; leg. P. Schwendinger.

DISTRIBUTION: Known only from the type locality in the southern part of eastern Thailand.

Liphistius thaleri Schwendinger, 2009 Figs 59-64

Liphistius thaleri Schwendinger, 2009: 1255-1260, figs 1-12 (description of male and female).

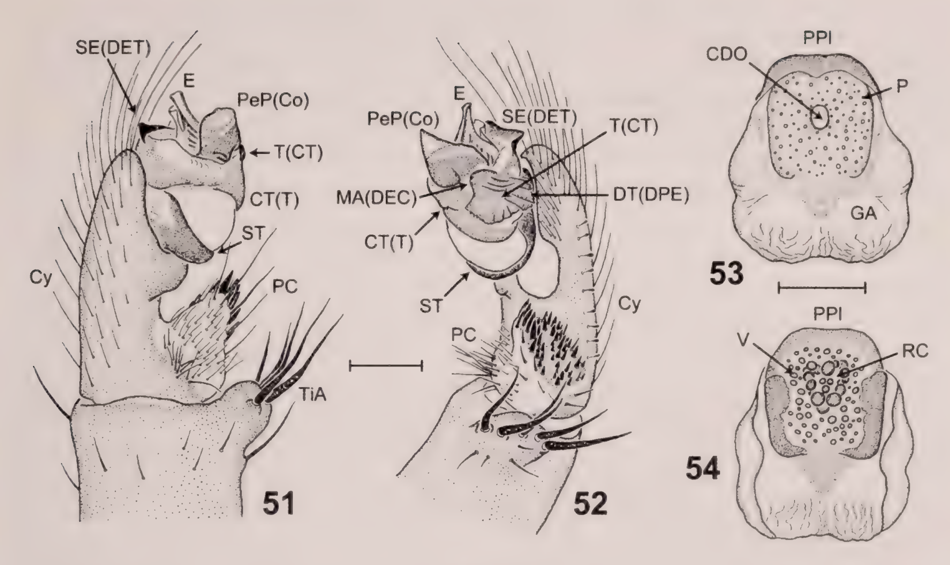
MATERIAL EXAMINED: MHNG, without registration number; male holotype, 5 male paratypes, 8 female paratypes; Thailand, Trang Province, Libong Island, 30 m; 20.VII.2005; leg. P. Schwendinger.

DISTRIBUTION: Known only from Libong Island in southern Thailand.

DISCUSSION

TAXONOMIC CHARACTERS AND TERMINOLOGY: Different and partly contradictory terminology (for a summary see Table 1) for genital structures of liphistiid spiders has been used in taxonomic publications by various authors.

Conductor: Haupt (1979: 358, 360-361, figs 8-10 and subsequent papers of the same author) used the term “conductor” for a distad-directed spine-like structure on the palpal organ of *Ryuthela* males. This spine arises on the ventral side of the contrategulum and is actually a strongly elongate denticle, the last (proximal-most) one in a series (continuous or interrupted) of denticles that run down from the distal edge of the contrategulum in all heptatheline palps examined (denticles indistinctly developed in



FIGS 51-54

Liphistius ornatus Ono & Schwendinger, 1990, male holotype (51-52) and female paratype (53-54). (51) Distal part of left palp, ventral view. (52) Same, retrolateral view. (53) Vulva, dorsal view; dorsal and lateral walls of bursa capulatrix and genital atrium not shown. (54) Same, ventral view. CDO = central dorsal opening; Co = conductor; CT = contrategulum; Cy = cymbium; DEC = distal edge of "contrategulum"; DET = dorsodistal edge of "tegulum"; DPE = dentate proximal edge of "contrategulum"; DT = dorsal extension of terminal apohysis of tegulum; E = embolus; GA = genital atrium; MA = marginal apophysis of tegulum; P = medium-sized pore (leading to ampulliform vesicle); PC = paracymbium; PeP = paraembolic plate; PPl = poreplate; RC = receptacular cluster; SE = sharp distal edge of contrategulum; ST = subtegulum; T = tegulum; TiA = tibial apophsis; V = ampulliform vesicle. Scale lines 1.0 mm. Modified from Ono & Schwendinger, 1990: figs 1-4, with permission from the Bulletin of the National Science Museum (Tokyo).

H. kimurai, Fig. 47; modified to ribs in *H. tomokunii*, Figs 39-40). In *R. owadai* the three proximal denticles are elongate to various degrees (Figs 48, 50; Ono, 1997b: figs 16-18). Thus the "conductor" of *Ryuthela* is not fused with the contrategulum as suggested by Haupt (1983: 286; 2003: 71), it is an original part of the contrategulum and as such also of the bulbal sclerite II sensu Kraus (1978: 237, figs 2-4). In other heptatheline genera the conductor is a structure of various shapes that arises from the ventral base of the embolus (or embolus complex) and thus belongs to bulbal sclerite III. Consequently the "conductors" of both groups are not homologous and therefore should not both be called the same. In his descriptions of various *Ryuthela* species Ono correctly notes: "contrategulum with a basal spine; conductor not developed" (e.g., Ono, 1997b). The elongate basal denticle of the contrategulum, in the following called contrategular spine, is unique within the Liphistiidae and a clear synapomorphy for species in *Ryuthela*. Raven (1985: 15, 16) also did not recognize the different origins of the *Ryuthela* and *Heptathela* "conductors" but just their different shapes, and gave this as one of the reasons to synonymise *Ryuthela* with *Heptathela* (*Ryuthela* was later removed from synonymy by Haupt, 2003: 71).

The conductor of *Heptathela* is on the same bulbal sclerite (III) and essentially in the same position as the "paraembolic plate" (also called "scale-like plate of the ventral embolus edge", "proximal edge of embolus" and "Basalkante des Embolus") present in many species of *Liphistius* (especially in those of the *trang*-group; Figs 51-52). These sclerites differ only in shape and in distance to the embolus proper: in *Liphistius* the paraembolic plate is wide, short or long, fairly remote from the embolus and slightly inclined from it, whereas in non-*Ryuthela* heptathelines the conductor is wide or narrow, long, usually lies much closer to the embolus and runs more or less parallel to its surface. The relative position of the conductor in *H. tonkinensis* (type species of "*Nanthela*"; Figs 34, 36) is intermediate between that of *Liphistius* and *Heptathela*. Differences in shape [paraembolic plate scale-like (Fig. 51) or only developed as a low wide edge in *Liphistius* (Schwendinger, 1998: fig. 1A-D, I); conductor leaf-shaped in *Heptathela* from Japan (Haupt, 2003: fig. 52F-K, M-P, fig. 62G-L), proximally broad and usually carrying three more or less pronounced, acutely pointed tips in *"Sinothela"* (Haupt, 2003: fig. 52L, fig. 62D-F), blade-like, spiniform and smooth, or spiniform and apically dentate in *"Nanthela"* (Haupt, 2003: fig. 62C)] do not exclude that these structures are homologous. This was stated by Raven (1985: 15) and vigorously refuted by Haupt (2003: 92); we here support Raven's view.

The terms "conductor" and "contrategulum" were confused in Ono's (1998) taxonomic treatment of the males of five *Heptathela* species from Kyushu Island (Japan). What is correctly referred to as "conductor" in the descriptive text (except on page 21), is incorrectly called "contrategulum" in the legends to the corresponding figures.

Tegulum: Tegulum and contrategulum are the two more or less distinctly outlined parts of the ring-shaped bulbal sclerite II of the palpal organ in Liphistiidae. In the Heptathelinae the tegulum extends over the dorsal and retrodorsal side of the bulb and carries two apophyses: 1) Dorsally lies the distad-directed marginal apophysis over which runs a sharp distal edge from the prolateral to the retrolateral side. This apophysis is long and pointed in *H. australis* and *H. nui* sp. n. (Figs 2-5, 10, 22-25, 28-29), short and arched in the other heptatheline species examined (Figs 34, 37-38, 39, 45, 47-48). 2) Retrolaterally lies the retrolaterad-directed terminal apophysis over which runs a more or less coarsely dentate (least developed in *R. owadai*) dorsal edge perpendicular to the distal edge on the marginal apophysis. The terminal tegular apophysis is distinctly developed in "*Nanthela*" and *Heptathela* (Figs 3, 5, 10-14, 23, 25, 28, 34, 36-39, 41, 45, 47), indistinctly so in *Ryuthela* (Fig. 48). In *H. australis* and *H. nui* sp. n. the dorsal side of the terminal tegular apophysis is only moderately extended and slightly arched, with the dorsal dentate edge only little elevated (Figs 5, 25), in the other Heptathelinae examined it is strongly protruding into a widely arched extension (Figs 34, 36, 39, 47-48; not visible in Fig. 45). In *H. kikuyai* and *H. kimurai* there is a coarsely dentate third edge on the tegulum (= the "first edge" of Song & Haupt, 1984: 444) which starts at the point where the edges of the marginal and terminal tegular apophyses meet, and from there it runs down the prodorsal side to the base of the tegulum. This edge is not produced into an apophysis as on the other two tegular edges. This condition appears to be characteristic for *H. kimurai* (the type species of *Heptathela*) and its closest relatives. In the other Heptathelinae the edges of the marginal and terminal apophyses do not meet prodorsally and no third edge is present.

In *Liphistius* the tegulum is less obvious, because it seemingly does not possess the same apophyses as the tegulum of the Heptathelinae. The so-called "tegular process" of some *Liphistius* species arises from the opposite (= ventral to proventral) side of bulbal sclerite II and thus belongs to the contrategulum. The contrategular process is probably apomorphic for *Liphistius*, as is also the subtegular apophysis (both present only in some species); both apophyses are absent in all Heptathelinae. What was previously called "tegulum" in *Liphistius* therefore does not correspond to the tegulum in the Heptathelinae. There is, however, a sclerotised area on the retrodorsal side of bulbal sclerite II in *Liphistius* that is connected to the larger part (= the contrategulum) of bulbal sclerite II by a narrow sclerotised area and that carries a sharp distal edge in most species and a dentate marginal or submarginal proximal edge in all species (Fig. 52, Schwendinger, 1996: figs 1, 12, 21, 31, 39, 46, 55, 65, 74, cf. Figs 4, 24). These two edges, though being more two-dimensional, resemble the marginal and terminal tegular apophyses of Heptathelinae and they lie at the same position on the palpal organ. Haupt (1983: figs 1c, 3-4) called the sclerite of the *Liphistius* palp which carries these two edges the "contrategulum", and that appellation was followed in papers on *Liphistius* by Ono and by Schwendinger. We assume that Haupt regarded this sclerite as the "contrategulum" because of a misinterpretation of his own illustration (see Haupt, 1983: fig. 1c) that shows a distinctly expanded male palp of *L. malayanus* Abraham, 1923 in which the so-called "contrategulum (K)" was rotated to the ventral side where the contrategulum is situated in the Heptathelinae (see Haupt, 1983: fig. 1b). In his illustrations of non-expanded *Liphistius* palps (see Haupt, 1983: figs 3b-c, 4a-b), however, the so-called "contrategulum (K)" lies on the other side, retrodorsally, where the tegulum of the Heptathelinae is situated. Correspondingly the latter figures show the so-called "tegulum (T)" proventrally, where the Heptathelinae have the contrategulum. Haupt has obviously confused these terms in both taxa. The tegulum of *Liphistius* (hitherto incorrectly called "contrategulum") is much shorter and narrower than that of the Heptathelinae, and it is confined to the retrodorsal side of bulbal sclerite II. The dentate proximal or subproximal edge of the tegulum of *Liphistius* is presumably homologous with the dentale edge on the dorsal side (protruded into a dorsal extension in some species) of the terminal tegular apophysis of the Heptathelinae, and the more or less distinctly developed distal edge of the *Liphistius* tegulum is presumably homologous with the marginal apophysis of the Heptathelinae (Fig. 52 cf. Figs 4, 24). A fairly simple tegulum (more reduced than in *Heptathela* but less than in *Liphistius*) is also present in *Ryuthela owadai* (Fig. 48). We consider the small tegula of *Liphistius* and *Ryuthela* as homoplasic reductions, which implies that the palpal organs of *Liphistius* and (to a lesser degree) *Ryuthela* are more derived than those of *Heptathela*.

Contrategulum: Haupt (1983: 277) introduced the term "contrategulum" for the prolateral to ventral part of bulbal sclerite II that opposes the tegulum. In the Heptathelinae tegulum and contrategulum are more or less distinctly separated by a wide membranous zone (haematodocha) retroventrally, thus forming a broken ring. Prodorsally, however, both parts are widely fused and it is difficult to tell where the contrategulum ends and the tegulum begins. An indicator is the sharp distal edge of the contrategulum portion which more or less abruptly ends prolaterally in *H. australis*

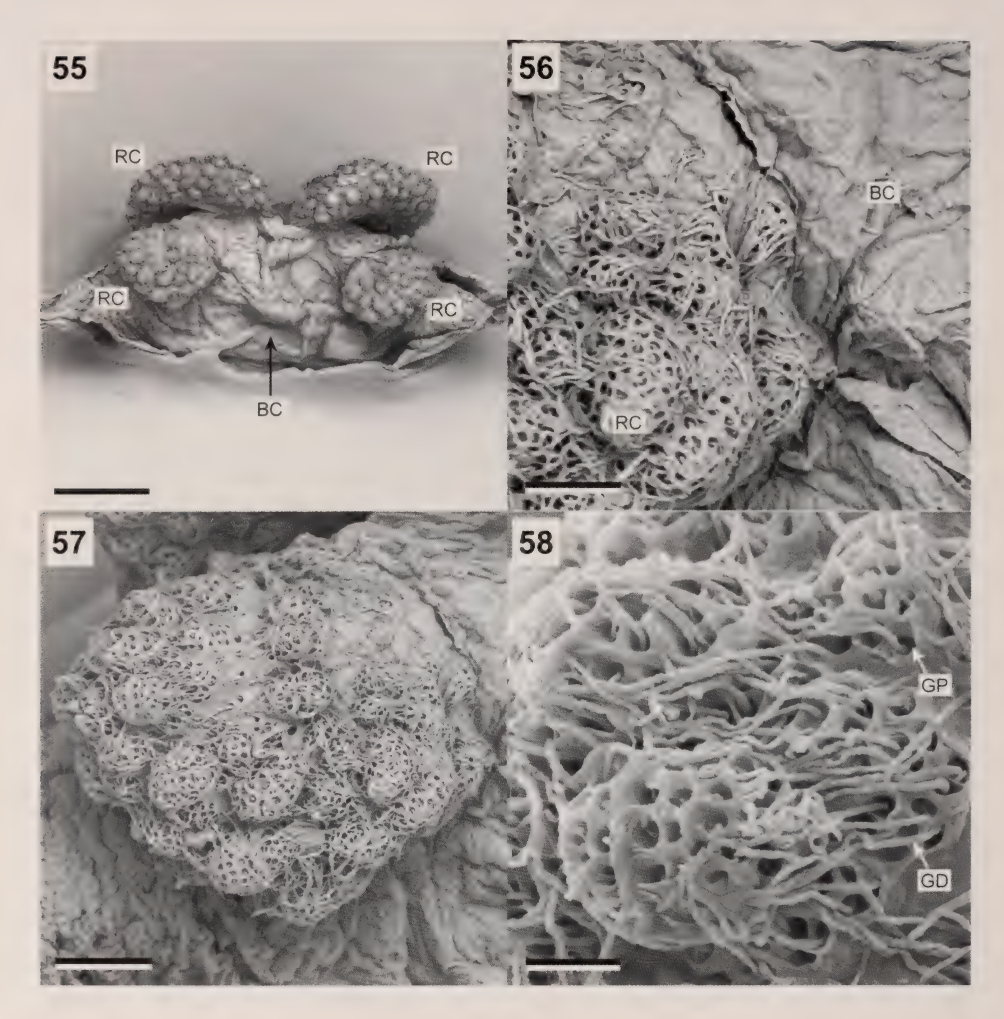
(Fig. 2), *H. nui* sp. n. (Fig. 22), *H. kikuyai* and *H. kimurai*, wereas in *H. tonkinensis* (Figs 34, 36), *H. tomokunii* (Fig. 39) and *R. owadai* (Fig. 48) it fades out between the marginal tegular apophysis and the embolus. More proximally at that place contrategulum and tegulum are usually fused with each other without a transition, though in *Hepthatela* males from Japan examined a small invagination in the proximal margin of bulbal sclerite II presumably marks the border between both parts. In *Ryuthela* this pattern is modified and the distinction between contrategulum and tegulum is more visible on the dorsal side of the palpal organ: the contrategulum is much wider than in other heptathelines (as wide as in *Liphistius*) and extends distally past the tegulum to the retrolateral side in an almost complete circle; a deep, almost horizontal furrow divides both sclerites dorsally (Fig. 48), and only on the ventral side are tegulum and contrategulum completely fused (Fig. 50). In *R. nishihirai* tegulum and contrategulum appear to be completely separated (see Haupt, 1979: 360, fig. 9). In *Liphistius* the contra - tegulum is much more extensive than the tegulum, almost completely embracing the middle portion of the palpal organ (as also in *Ryuthela*, but there the tegulum is much wider than in *Liphistius* and overlaps the contrategulum). Retrolaterally the large contrategulum and the much smaller tegulum are connected by sclerotised bridges (the more dorsal one always narrower than the more ventral one) and form a closed ring (Fig. 52). What was previously called "tegular process", "distal edge of tegulum" and "dorsal edge of tegulum" in various publications on *Liphistius* by Haupt and by Schwendinger, are in fact parts of the contrategulum.

In Heptathelinae the contrategulum usually carries on its distal edge (which is divided into a sharp outer edge and a dentate inner edge in *H. australis* and *H. nui* sp. n.) a row of denticles which are more or less distinctly connected to a few (in some species isolated) denticles ventro-proximally. These denticles were subject to evolu - tionary modifications of taxonomic significance. In several species they have multiplied and become more than one row deep: in *H. nui* sp. n. two rows proximally (Fig. 23), in *R. owadai* three rows proximally (Fig. 50), in *H. kikuyai* several rows proximally (Fig. 45) and in *H. tonkinensis* several irregular rows on most of its distal edge (Fig. 36); in *H. tomokunii* (Figs 39-40) and seemingly also in *H. hongkong* Song & Wu, 1997 (Haupt, 2003: fig. 51D) they have transformed into a series of parallel edges or ribs. Such ribs are also present in some *Liphistius* species where they are probably homoplasic (see Schwendinger, 1995: figs 22-23, 26-27; Schwendinger, 1996: figs 12, 15-17; Schwendinger, 1998; fig. 5b, e-f). In *Ryuthela* spp. the basalmost of these denticles (in *R. owadai* to a lesser degree also two adjacent ones; Figs 48, 50) has become strongly elongate and spine-like. This modified contrategular denticle of *Ryuthela* is clearly not homologous to the conductor (or paraembolic plate) of other Liphistiidae (see discussion of conductor), but it presents a clear synapomorphy for species in *Ryuthela*.

Cymbial projection: Haupt (2003: 69, 94, character 23 in table 11 and fig. 61) considers the elongate proventral cymbial lobe as "autapomorphic" (Haupt, 2003: 94; it should read "synapomorphic") and distinctive for males of species in the genus *"Nanthela"*. However, this modification is also present in two *Heptathela* species from Japan examined: *H. kikuyai* (Fig. 44) and *H. kimurai* (Fig. 46; the type species), and it is also discernible in Song & Haupt's (1984: fig. 1c) illustration of the male palp of

H. schensiensis (previously in *"Songthela"*) and in Haupt's (1983: fig. 10a-d) illustrations of the male palp of *Ryuthela nishihirai* and *R. ishigakiensis* Haupt, 1983. In *R. owadai* the cymbial projection is only weakly developed (Fig. 49). In some *Liphistius* species (e.g., *L. bristowei* Platnick & Sedgwick, 1984 and *L. batuensis* Abraham, 1923; in MHNG examined), on the other hand, it is the prodorsal cymbial lobe (instead of the proventral one) that is moderately elongate. Thus it appears that one of the cymbial lobes (the proventral one in Heptathelinae, the prodorsal one in *Liphistius*) has become elongated to various degrees independently in different phylogenetic lineages. The taxonomic value of this character at the generic level has thus been overestimated.

Vulva: HEPTATHELINAE. The vulva of heptatheline spiders is composed of two main parts (see Fig. 19): 1) The posterior part is a long and wide entrance area (= the genital atrium) furnished with numerous hairs on the dorsal and ventral walls in *H. australis* (Fig. 16), *H. nui* sp. n. (Fig. 31) and *H. tomokunii* (Fig. 42), but only on the dorsal wall in *H. kikuyai*, *H. kimurai*, *R. owadai* and *R. nishihirai*. The genital atrium is overlapped by a more or less tongue-shaped projection of the posteromedian margin of the genital sternite. 2) The anterior part of the vulva is a blind-ending pouch (= the bursa copulatrix) in the form of a flattened bell (see Ono, 2002a: fig. 3), plano-convex or trapezoidal in dorsal and ventral view, with walls consisting of a light yellow, tough, leathery but not sclerotised cuticle (Figs 16-19, 31-33, 42-43, 55). As already stated by Forster (1980: 280), there is no sclerotised structure in the vulva of heptatheline spiders that can be called a genital plate (an incorrect term used by several authors; see Table 1]. Usually no pores are present in the walls of the bursa copulatrix (Figs 55-56), but the largest *H. australis* female has tiny pores on the small vesicles that lie scattered between the receptacular clusters (Fig. 16). This could be an atavism (see *Evolution of female copulatory organs*). From the dorsal side of the vulva, where both main parts meet at an obtuse angle, a short and wide, dorsoventrally depressed membranous collar (= the uterus externus) leads dorsad to the mesodermal part of the oviduct (= the uterus internus) and further to the ovary (Fig. 19). In the illustrations by Haupt (1983: fig. 2b) the entrance to the uterus externus is erroneously shown at the anterior end of the bursa copulatrix, which is in fact a cul-de-sac. The anterior margin of the bursa copulatrix carries between one and four sessile or stalked, mostly cauliflower-shaped protuberances (= the receptacular clusters) composed of numerous more or less strongly sclerotised vesicles (= the receptacles). The composite structure of the receptacular clusters in heptathelines (for *Ryuthela nishihirai*) was first recognized by Haupt (1979: 365). The walls of these vesicles are perforated by tiny micropores through which surrounding glands empty. The proximal, cuticular portions of the gland ducts that are sticking out of the micropores like fine hairs (Figs 56-58; SEM-micrographs taken from exuviae) clearly show that these are indeed gland pores. In the two females of *H. tomokunii* examined these anterior protuberances on the bursa copulatrix are simple in shape and have a fairly smooth surface (though also perforated by micropores; Figs 42-43) and may be called receptacles. This indicates a trend towards simplification, which is also seen in the receptacular clusters of some *Liphistius* species that have become smooth and digitiform (Sedgwick & Schwendinger, 1990; fig. 6; Schwendinger, 1996: figs 18-20, 52-54). In *H. australis* and other species previously



FIGS 55-58

Heptathela australis (Ono, 2002), SEM-micrographs of genitalia from the exuvia of one female, dorsal views. (55) Entire bursa copulatrix with receptacular clusters. (56) Border between dorsal wall of bursa copulatrix (without pores) and lower left receptacular cluster (with gland pores). (57) Lower left receptacular cluster. (58) Detail of the same showing gland pores and cuticular parts of gland ducts. BC = bursa copulatrix; GD = cuticular (proximal) part of gland duct; GP = gland pore (micropore); RC = receptacular cluster. Scale lines: 14 µm (58), 31 µm (56), 56 µm (57), 236 µm (55).

placed in *"Songthela"* by Ono (2000), two of these receptacular clusters (the lateral ones) have become displaced onto the dorsal wall of the bursa copulatrix and are directed dorsad instead of anteriad (Figs 16-19, 55).

Illustrations in the original description of *H. goulouensis* Yin, 2001 show a very different type of vulva (without a bursa copulatrix but instead with a pair of bifid "curved, tube-like stalks", each carrying a median and a lateral receptacle or receptacular cluster; Yin, 2001: figs 5-6, 8-9) which is similar to the vulvae of certain mygalomorph spiders. If correct, this would be most unusual for liphistiid spiders. A

re-examination of these specimens may show that the true boundaries of the bursa copulatrix were not recognized and that the "stalks" are actually zones of different pigmentation, or a mass of sperm inside the bursa copulatrix. Similar "stalks" and a short bursa copulatrix were illustrated for the holotype of *H. sapana* (Ono, 2010: fig. 16). The so called "didymous phenomenon" displayed by the female paratype of *H. goulouensis* (Yin, 2001: figs 8-9) is most likely based on a spider that was preserved prior to moulting, which has the new cuticle of the vulva already formed underneath the old cuticle.

The number of receptacles or receptacular clusters and their position on the bursa copulatrix is variable and this has been used to recognize groups of species which were given generic rank. *Ryuthela* is characterized by only two anterior receptacular clusters situated close to each other (Haupt, 2003: 71, fig. 53), but a rudimentary pair of additional (lateral) receptacular clusters is still present in the female "allotype" of *R. owadai* (see Ono, 2001: figs 2-3). This is not so in the corresponding female paratype examined. Non-*Ryuthela* Heptathelinae usually have four more or less distinctly developed receptacles or receptacular clusters, but distinction from *Ryuthela* is not clear-cut. Lateral receptacular clusters have become more or less fused with median ones in several *Heptathela* species (see Ono, 1998: figs 9-10, 15-16, 17-20, 31-32; Haupt, 2003: fig. 54), resulting in only two anteromedian receptacular clusters which are generally more widely separated from each other than in *Ryuthela*. The holotypes of *H. hunanensis* Song & Haupt, 1984 and of *H. cucphuongensis* have the median pair fused and the lateral pair still isolated, resulting in a vulva with three anteromedian receptacular clusters (Song & Haupt, 1984: fig. 3e; Ono, 1999: fig. 8). Ono (2000) used this intermediate character state to establish the genus *"Vinathela"* (misspelled *"Viathela"* and placed in the synonymy of *Heptathela* by Haupt, 2003: 71, 79). Fusion of receptacular clusters has gone even further: the illustrated vulva of *R. iheyana* Ono, 2002 has a single, wide and short anteromedian receptacular cluster (Ono, 2002b: figs 2-3); the holotype and one female paratype of *R. sasakii* Ono, 1997 have a single, long and narrow anteromedian receptacular custer (Ono, 1997b: figs 5-8). We consider all these forms as intermediate stages of reduction and fusion of the four anterior receptacular clusters that are plesiomorphically present in heptatheline spiders. Such modifications probably have evolved independently in different phylogenetic lineages and should be treated with caution when establishing relationships between species.

Two receptacular clusters displaced to the dorsal side of the bursa copulatrix (Figs 16-19, 55) is another kind of modification in heptatheline vulvae. This character state was used by Ono (2000) to establish the genus *"Songthela"*, but as *H. australis* (described in *"Songthela"*) has it and the obviously closely related *H. nui* sp. n. not, it can no longer be used as distinctive on the generic level. All the more so because several transitional steps exist: the lateral receptacular clusters of *H. tomokunii* (see Figs 42-43; Ono, 1997a: fig. 6), *H. sinensis*, *H. schensiensis* (see Song & Haupt, 1984: fig. 3a-b, f) [the latter two placed in *"Abcathela"* by Ono, 2000, in *"Sinothela"* by Haupt, 2003 and then in *"Songthela"* by Platnick, in an earlier version of his 2011 online catalogue] and of *H. yunnanensis* Song & Haupt, 1984 (see Song & Haupt, 1984: fig. 3f) are also slightly displaced onto the dorsal wall of the bursa copulatrix, but not as far back as in *H. australis* (Figs 16-18, 55) and as in *H. hangzhouensis* (see Song &

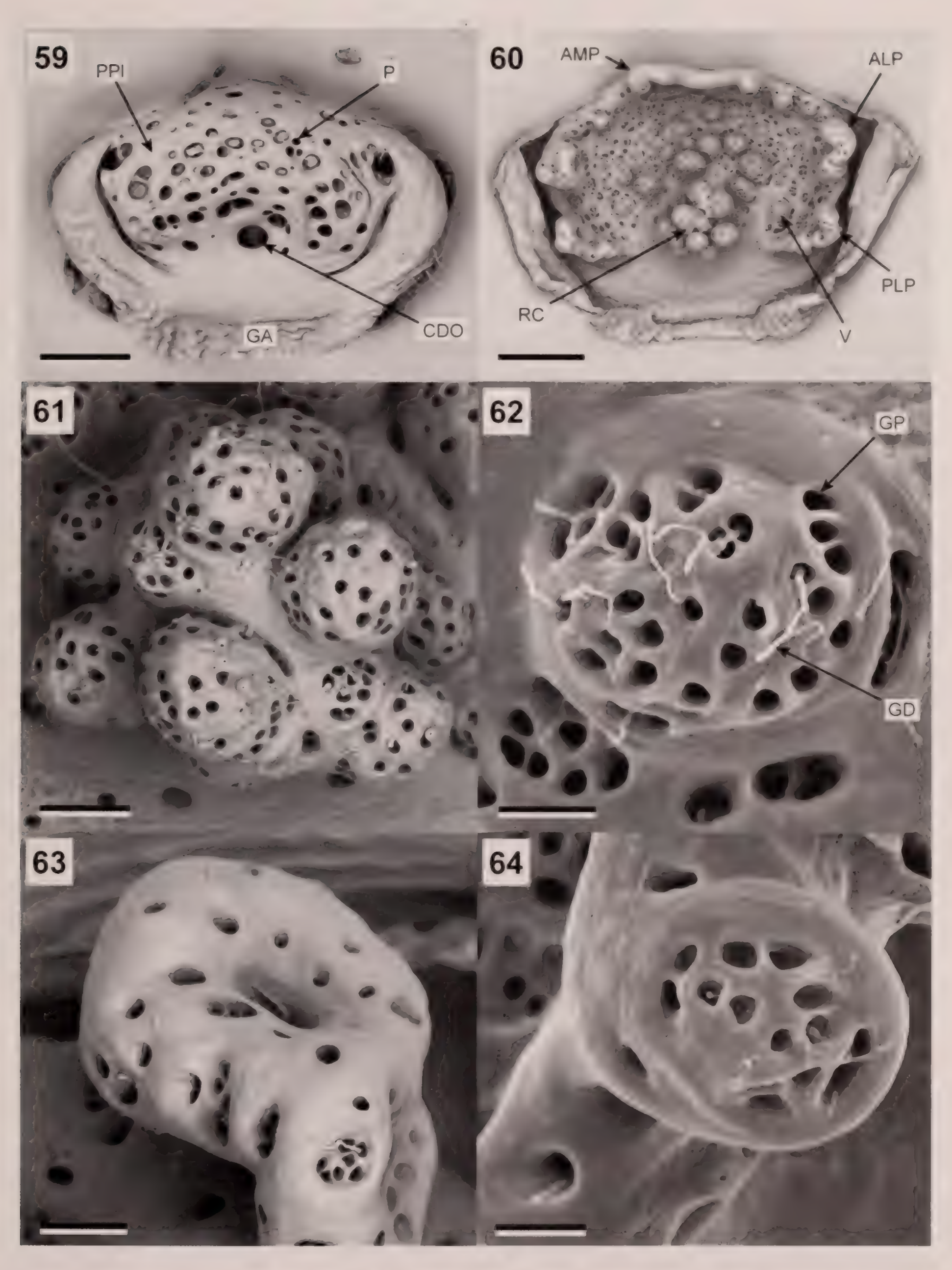
Haupt, 1984: fig. 3c-d) (both species previously in *"Songthela"*). The median pair of receptacles (reduced receptacular clusters) of *H. tomokunii* (Figs 42-43; in addition to the lateral pair which was slightly displaced onto the dorsal wall) and of some *Ryuthela* species (see e.g., Ono, 1997b: figs 5-14, 19-22) is even sitting slightly below the anterior margin of the bursa copulatrix, on its ventral wall (thus on the same side as the receptacular cluster of *Liphistius*).

LIPHISTIIDAE. The heptatheline vulva is largely different from the vulva of *Liphistius* which carries no anterior receptacular clusters. In that genus the dorsal wall of the bursa copulatrix is a thin transparent membrane that never carries any modifications apart from a pigmented spot opposing the macropore in the ventral wall in a few large females. (In *Liphistius* the entrance to the uterus externus is also situated at the border between atrium and bursa copulatrix, not at the anterior end of the bursa copulatrix as shown in Haupt, 1983: fig. 2a). The ventral wall of the bursa copulatrix in *Liphistius* is strongly sclerotised and includes a true genital plate (= the poreplate) perforated dorsally by medium-sized pores that lead inside small ampulliform vesicles on the ventral side (Figs 53-54, 59-60). The appellation "gland pores" used in a paper by Schwendinger (1996) for these vesicles is incorrect; the gland pores (= micropores) are actually on the ouside of the vesicles (ventrally on the poreplate), as clearly visible in SEM-micrographs by Kraus (1978: fig. 8; see also Fig. 62). Kraus (1978: 242-243, figs 6-8) called these vesicles "circular structures [or circular areas] … interpreted … as a pore system for glands … [which] must not be confused with the receptacula". Kraus (1978: fig. 8) first showed SEM-micrographs of micropores in *Liphistius* and recognized the function of the ampulliform vesicles, but the corresponding lettering is misleading [in fig. 8 the ventral surface of a vesicle is labelled as "gland pore", in fig. 6 the opening (= medium-sized pore) of a vesicle on the dorsal side of the poreplate]. Sperm that enters into the ampulliform vesicles from the dorsal side of the poreplate is thus supplied with (or flushed out by) a secretion of the receptacular glands from the other side. Thus the vesicles on the ventral side of the Liphistius poreplate are sperm receptacles.

On the dorsal side of the *Liphistius* poreplate a fairly large central opening (or macropore; CDO in Figs 53, 59) leads to an unpaired, strongly sclerotised receptacle or (in most species) receptacular cluster (Figs 54, 60-61; Haupt, 2003: 68 called this an "unpaired ventral sac") on the ventral side of the poreplate. The central receptacular cluster is perforated by gland pores, and it varies in shape from simple and digitiform (in that case called a receptacle, see Sedgwick & Schwendinger, 1990; fig. 6; Schwendinger, 1996: figs 18-20, 52-54) to complex and cauliflower- or popcorn-shaped (Kraus, 1978: figs 5-8; Platnick & Sedgwick, 1984: figs 69, 80, 87). In the heptatheline vulva no receptacle or receptacular cluster is found at this position (although shown there in Haupt, 1983: fig. 2b), but a slight displacement of the median pair onto the ventral side of the bursal copulatrix can be seen in *H. tomokunii* (Figs

FIGS 59-64

Liphistius thaleri Schwendinger, 2009, SEM-micrographs of vulvae from the exuviae of three female paratypes. (59) Ventral wall of opened bursa copulatrix and genital atrium, dorsal view. (60) Same, ventral view. (61) Receptacular cluster. (62) Ampulliform vesicle. (63) Anterolateral



protuberance on rim of poreplate. (64) Posterolateral protuberance on rim of poreplate. ALP = anterolateral protuberance on rim of poreplate; AMP = anteromedian protuberance on rim of poreplate; CDO = central dorsal opening (macropore) to receptacular cluster on other side; GA = genital atrium; GD = cuticular (proximal) part of gland duct; GP = gland pore (micropore); P = medium-sized pore (leading to ampulliform vesicle); PLP = posterolateral protuberance on rim of poreplate; PPl = poreplate; RC = receptacular cluster; V = ampulliform vesicle. Scale lines: 14 μm (64), 16 μm (62), 32 μm (63), 35 μm (61), 195 μm (59), 205 μm (60).

42-43) and in several *Ryuthela* species (Ono, 1997b: figs 9-14, 19-22). In *R. sasakii* this pair has become fused, it possesses a common unpaired, slightly ventrally situated, fairly large opening (macropore; see Ono, 1997b: figs 5, 7), and thus resembles the receptacular cluster in *Liphistius*.

Several *Liphistius* species possess 1-3 pairs of ventrad-directed protuberances on the thickened anterior and lateral margins of the poreplate (Fig. 60). These appear to be synapomorphic for members of superspecies D of the *trang*-group (co-occurring with a synapomorphic subtegular apophysis in males of these species, see Schwendinger, 2009; subtegular apophyses in the *bristowei*-group are homoplasic), but also occur in distantly related species in other species groups (e.g., Platnick & Sedgwick, 1984: figs 13, 21, 78; Schwendinger, 1990: figs 2-4, 37-39, 43-45, 47-49, 53-56). These protuberances are hollow, in contact with the bursa copulatrix through medium-sized pores on the dorsal side of the poreplate, and their walls are perforated with micropores through which gland ducts enter (Figs 60, 63-64). Therefore the ventral marginal protuberances are functional sperm receptacles. Function and position of these protuberances suggest that they are homologous with the receptacular clusters of the heptatheline vulva, but considering that the poreplate in *Liphistius* itself is an apomophic structure, that is quite unlikely. We regard these protuberances as outgrowths on the thickened margin of the poreplate, which have developed several times independently in *Liphistius*. They are useful for species distinction, and their number and position on the poreplate allow recognizing relationships between species.

Micropores are not only found in the elevated parts of the ventral side of the poreplate, but also in the flat parts between them (Figs 60, 62). Most of the pores there are grouped and sitting in shallow depressions, with membranous gland duct bases sticking out of them, and these groups of sessile micropores are in contact with medium-sized pores on the dorsal side of the poreplate. Thus essentially the whole of the poreplate serves as a sperm receptacle.

Evolution of female copulatory organs: The fact that two very different types of vulvae exist within the Liphistiidae raises the questions: how did they evolve and which one is more derived than the other? Five hypotheses were put forward in an attempt to explain the evolution of female copulatory organs in Liphistiidae and in Araneae as a whole:

1) Platnick & Gertsch (1976: 6), and subsequently Platnick (1977: 13), postulated that in ancestral spiders the palps were pressed simultaneously into the female genital tract during copulation, and that the tips of embolus and conductor of each palpal organ left imprints in the wall of the vulva which developed into receptacles. A vulva with four receptacles, as found in most Heptathelinae and in some basal Mygalomorphae and basal Araneomorphae, is thus plesiomorphic for the Araneae.

2) An alternative hypothesis, put forward by Forster (1980: 277, fig. 12) and further elaborated by Forster, Platnick & Gray (1987: 94-98), presents an archetypical spider vulva with only a large and simple bursa copulatrix supported by a secretory gland system that empties through pores in the anterior wall of the bursa. According to this hypothesis, numerous receptacles (vesicles) developed later by invagination (better called exsacculation) of the bursal wall where the gland pores are situated. In this view the *Liphistius* vulva is relatively primitive because it still has numerous indi-

TABLE 1. Different terminology used for homologous genital characters in three groups of liphistiid spiders by various authors in 14 selected publications. Forster (1980[1]); Haupt (1979[2], 1983[3], 2003[4]); Kraus (1978[5]); Ono (1997b[6]); Ono (1998[7]); Ono & Nishikawa (1989[8]); Schwendinger (1990[9], 1996[10], 2009[11]), Song & Haupt (1984[12]), Yin (2001[13]), present paper[14]. Abbreviations (in parentheses) correspond to those given in Figs 1-64. Terms between inverted commas are considered as inappropriate or incorrect.

Heptathela (see Figs 1-47, 55-58, 67-68)	*Ryuthela* (see Figs 48-50)	*Liphistius* (see Figs 51-54, 59-64)
conductor (Co)[2, 3, 4, 7, 12, 14], "contrategulum" (CT)7	-	para-embolic plate (PP)[10, 11, 14]; "posterior" edge of embolus[9]; scale-like proximal embolus edge[9]; broad lamella at base of embolus[4, 5]; Chitinplatte auf Basalkante des Embolus[3]; conductor[14]
ventro-proximal denticles on contrategulum[14]	"conductor"[2, 3, 4]; spine on contrategulum[6]; contrategular spine (CS)[14]	-
contrategulum (CT)[3, 4, 7, 8, 12, 14]	Medianapophyse[2]; contrategulum (CT)[6, 14]	"tegulum" (T)[3, 4, 9, 10, 11]; contrategulum (CT)[14]
tegulum (T)[3, 4, 7, 8, 12, 14]	tegulum (T)[2, 3, 4, 6, 14]	"contrategulum" (CT)[3, 4, 10, 11]; tegulum (T)[14]
terminal apophysis of tegulum[12]; third tegular edge[12]; dentate edge of dorsal extension of terminal apophysis of tegulum (DT)[14]	dentate edge of dorsal extension of terminal apophysis of tegulum (DT)[14]	dentate proximal edge of "contrategulum" (DPE)[10]; "ventral" edge of "contra-tegulum"[11]; dentate edge of dorsal extension of terminal apophysis of tegulum (DT)[14]
marginal apophysis of tegulum (MA)[12, 14]; second tegular edge[12]	marginal apophysis of tegulum (MA)[14]	distal edge of "contra-tegulum" (DEC)[10]; "dorsal" edge of "contrategulum"[11]; distal edge of tegulum[14]; marginal apophysis of tegulum (MA)[14]
genital plate[4, 12, 13]; Genital-platte[3]; dorsal and ventral walls of bursa copulatrix[14]	Genitalplatte[3]; Atrialplatte[3]; dorsal and ventral walls of bursa copulatrix[14]	Genitalplatte[3]; Atrialplatte[3]; receptaculum[4]; chitinous plate[5]; inner plate[5]; internal plate[5]; poreplate (PPl)[1, 14]
receptacula[1, 3, 4, 12, 13]; receptacles (R)[14]; receptacula organ[13]; receptacular clusters (RC)[14]; spermathecae[7, 8]	receptacula[2, 3, 4]; receptacular clusters (RC)[14]; spermathecae[6]	receptaculum[9, 10, 14]; receptacular system[5]; central receptacular cluster (RC)[9, 10, 11, 14]; pseudo-receptaculum[1]; unpaired ventral sac[4]

vidual receptacles [plus an autapomorphic unpaired "pseudo-receptaculum" (= the central receptacular cluster)] embedded in the poreplate, whereas the heptatheline vulva has developed further away from the ancestral form through a bilateral aggrega - tion of receptacles into receptacular clusters and through a reduction of the poreplate (Forster, Platnick & Gray, 1987: 98).

3) A similar interpretation was given by Kraus (1978: 235, 249), who considers the *Liphistius*-type vulva (with an unpaired central receptaclular cluster) as the most primitive within the Araneae and postulated that vulvae with paired receptacles (and also those with unpaired ones) derived from it.

4) Haupt took elements of the previous hypotheses to explain the evolution of female copulatory organs in spiders. He postulated an ancestral vulva with a large bursa copulatrix and irregularly arranged gland pores (Haupt, 1983: 288), as did Forster (1980), but referred to Kraus (1978) who proposed a different hypothesis (see above). Localised receptacles were assume to have formed later in co-evolution with the split tips of the embolus (Haupt, 1983: 288). In his cladogram of mesothelid systematics and in the corresponding character evaluation Haupt (1990: 136, fig. 1) follows Kraus (1978) and regards the vulva of *Liphistius* as plesiomorphic and that of Heptathelinae as apomorphic. Later, however, he noted that "it cannot be decided with certainty whether unpaired or paired receptacula in mesothelid spiders have to be considered as apomorphic for the group" (Haupt, 2003: 93).

5) Raven (1985: 15-16) regarded the vulva of *Ryuthela* (with a single pair of anteromedian receptacles) as plesiomorphic and assumed that the vulvae of *Heptathela* and *Liphistius* derived from it.

In view of the evolutionary tendencies for fusion and posteriad-displacement (to the dorsal and ventral walls) of four anterior receptacles or receptacular clusters in different lineages of heptatheline spiders, we believe that the same has also happened during the evolution of *Liphistius* species. We thus favour a combination of hypotheses 1 and 2 and consider the *Liphistius* vulva as derived from a proto-*Heptathela* vulva. That presumably resembled the vulvae of *H. nui* sp. n. (Figs 31-33) and of species from China and Vietnam previously placed in the genus *"Abcathela"* by Ono (2000), but had a much larger bursa copulatrix carrying four receptacular clusters on its anterior margin and possibly also scattered micro-receptacles on the walls of the bursa copulatrix more posteriorly. Such isolated micro-receptacles (vesicles penetrated by gland pores) are still present in the anterior part of the dorsal surface of the bursa copulatrix of the largest *H. australis* female examined (Fig. 16). This possibly is an atavism.

The pronounced differences in the vulvae of *Liphistius* and *Heptathela* indicate that the separation of both genera goes back much further in time than the separation of *Heptathela* and *Ryuthela*. The vulva of the latter is essentially a *Heptathela* vulva with a strongly reduced bursa copulatrix, with the receptacular clusters of each side fused to one another resulting in a single pair.

This interpretation is in line with the hypothesis of Schwendinger (2009: 1265-1266) that the Mesothelae originated in Euramerica before its integration into Pangaea, and from Euramerica spread eastward onto terranes that successively accreted to eastern Laurasia. In such a scenario, and knowing the very limited powers of dispersal of extant mesothelid spiders, one would rather expect to find the more basal extant species in southern and eastern China than further south, in Myanmar, Thailand, peninsular Malaysia and Sumatra. The latter lands mostly lie on the Sibumasu terrane which accreted to Laurasia later than the Chinese terranes and thus was colonized by Laurasian species later. This zoogeographic hypothesis and its implications for liphistiid phylogeny will be falsified as soon as an early (Palaeozoic or Mesozoic) mesothelid fossil is discovered on land of Gondwanan origin.

"Tibial spurs": The function of these paired structures distally on leg tibiae I-III (Platnick & Goloboff, 1985: figs 1-2; Haupt, 2003: fig. 16B-D), which must not be confused with coupling spurs ventrally or prolaterally on tibia I or tibia II in males of many mygalomorph spiders, is not yet understood. Platnick & Goloboff (1985) consider them as part of proprioreceptive sense organs in which the "tibial spurs" press against smooth oval patches at the bases of metatarsi I-III (Platnick & Goloboff, 1985: figs 3-4; Haupt, 2003: fig. 16B, D). Haupt (2003: 22, 95, fig. 16), however, assumes that the "tibial spurs", situated close to lyriform organs, are more likely used to monitor hemolymph pressure and strains in the cuticle, because they are allegedly not in contact with the metatarsal patches ("the bristle has no contact to the circular area of thinner cuticle"). This statement is incorrect. On alcohol-preserved specimens with stretched legs, or on a dry, stub-mounted and sputter-coated leg as shown by Haupt (2003: 16D), these structures are usually not in contact with each other, but they are so on live spiders sitting in ambush with slightly bent legs at the burrow entrance. Whatever the function of this sensory system is, its phylogenetic significance as a clear apomorphy of the Liphistiidae is undisputed. We found it to be present in all juvenile (also exuvia of penultimate males) and female liphistiids ever examined by both of us. "Tibial spurs" (but not always the light smooth paired patches on metatarsi I-III) are usually absent in mature males. In the male holotype of *H. tomokunii* and in the male paratype of *L. ornatus* (Ono & Schwendinger, 1990: 169-170) some "tibial spurs" are present but probably no longer functional.

SYSTEMATICS: Discoveries of new species or of the missing sex of described species occasionally challenge the concepts of established supraspecific taxa. This is also the case in the two *Heptathela* species from southern Vietnam. The female of *H. australis* corresponds perfectly to Ono's (2000: 150, fig. 4D) concept of *"Songthela"*, where this species was originally placed. Its newly discovered male, however, possesses the two characters considered by Haupt (2003: 69) as diagnostic for *"Nanthela"* (a cymbial projection present, conductor slender and much of its base fused to the embolus), and it also has a character considered in the same paper, on the same page, as diagnostic for *Heptathela* [paracymbium almost as long as cymbium (though relatively shorter in relation to the cymbium of *Heptathela* from Japan because that usually has no pronounced cymbial projection)]. The same type of male palp is present in the closely related *H. nui* sp. n., the female of which, however, possesses a vulva as in species previously placed in *"Abcathela"* (see Ono, 2000: 149-150, fig. 4C). This suggests that three of these four nominal genera (*"Abcathela"*, *Heptathela*, *"Nanthela"*, *"Songthela"*) do not reflect phylogenetic relationships. We rule out that *H. australis* and *H. nui* sp. n. are only distantly related. Geographical proximity and strong overall resemblance of the male palps show that these species are the most closely related. They share four likely synapomorphies in their male palps: 1) a very pronounced cymbial projection (more than in other heptathelines); 2) a long and pointed marginal tegular apophysis; 3) two parallel distal edges (one sharp, the other dentate) on the contrategulum; 4) an unpigmented and unsclerotised distoventral zone on the cymbium. Consequently these two species cannot be kept in different genera, and at the moment it appears most suitable to place them in the genus *Heptathela*.

The generic concept of *"Songthela"* is firmly rejected because the species included clearly do not represent a monophyletic group. Its single diagnostic character

(the dorsally displaced lateral receptacular clusters on the bursa copulatrix) is also present in species outside the genus, but it is not shared by the closely related species pair *"Songthela" australis* and *Heptathela nui* sp. n. The original concept of this genus does anyway no longer correspond to the currently included species apart from the type species, *S. hangzhouensis* (see Platnick, 2011). *"Songthela" australis* and *"Songthela"cipingensis* Wang, 1989 were transferred to *Heptathela* in an earlier version of Platnick's (2011) online catalogue, without giving an explanation. Three other species [*H. heyangensis* (Zhu & Wang, 1984), *H. schensiensis* and *H. sinensis*, all with a different type of vulva than in the type species] were included in *"Songthela"* by the synonymisation of *"Abcathela"* with *"Sinothela"* and then by the synonymisation of *"Sinothela"* with *"Songthela"*.

The generic concept of *"Nanthela"* is also rejected because it is not based on any clear apomorphies. One of the two diagnostic characters, the cymbial projection is also present in species outside *"Nanthela"*, e.g., in *H. kikuyai* (Fig. 44), *H. kimurai* (Fig. 46) and *"Sinothela" schensiensis* (see Song & Haupt, 1984: fig. 1c-d). The other diagnostic character of *"Nanthela"*, the slender conductor, is possibly plesiomorphic (Haupt, 1990: 137, fig. 1; Haupt, 2003: fig. 61, table 11). Instead of retaining this poorly defined genus and transferring species from the well-established genus *Heptathela* to it (*"Songthela" australis*, *H. nui* sp. n., *"Nanthela" tonkinensis*, *H. tomokunii* and presumably also other species form Vietnam form a distinct clade), we here place *"Nanthela"* in the synonymy of *Heptathela*.

We want to point out that the systematics of the Heptathelinae (except for the fairly well-defined and monophyletic group of species currently placed in the genus *Ryuthela*), as proposed by Ono (2000), Haupt (2003), Platnick (2011) and summarized in Table 2, are in dire need of a comprehensive revision based on genitalic characters of both sexes, and ideally also on molecular data. Until this is done (and the missing sexes are found), transferring or (in most cases) returning all non-*Ryuthela* Heptathelinae to *Heptathela* solves at least the problem of having closely related species in different genera. This solution is not ideal. *Ryuthela* appears to be an offshoot from within *Heptathela*, leaving the latter paraphyletic. At the moment no other monophyletic groups of species, which are sufficiently distinct to warrant generic rank, can be recognized within *Heptathela*. However, a more comprehensive study including the missing sexes (and new species yet to be discovered) may show that distinct clades do exist in *Heptathela* as defined here. If so, the 34 nominal taxa here included in *Heptathela* could be split into several genera again. In that case plenty of generic names will be available.

SUPPLEMENTARY OBSERVATIONS: *Venom glands and moulting position*: While Haupt's (2003) monograph is a very useful and comprehensive compilation of the knowledge of the Mesothelae of that time, his characterisation of the group includes two misinterpretations:

1) Haupt stated that mesothelid spiders do not possess venom glands ("Mesothelae, however, lack such venom glands. ... This can only mean that venom glands are an apomorphic character of Opisthothelae"; Haupt, 2003: 6), despite the detailed description and illustration of such a gland in *Liphistius desultor* Schiödte, 1849 by Millot (Bristowe & Millot, 1933: 1046, pl. 3, figs 1-2). This question has now

TABLE 2. Different generic placements of species of non-*Ryuthela* Heptathelinae in the original description, in two fairly recent publications establishing additional genera, in an online catalogue and in the present paper. [1] = species originally described as subspecies. — = species name not mentioned in the corresponding publication. Genus names between inverted commas are currently in synonymy.

Species	Original generic placement	Placement in Ono, 2000	Placement in Haupt, 2003	Placement in Platnick, 2011	Placement in present paper
abca Ono, 1999	*Heptathela*	*"Abcathela"*	*Heptathela*	*Heptathela*	*Heptathela*
amamiensis Haupt, 1983[1]	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
australis Ono, 2002	*"Songthela"*	—	—	*Heptathela*	*Heptathela*
bristowei Gertsch, 1967	*Heptathela*	*"Abcathela"*	*Heptathela*	*Heptathela*	*Heptathela*
ciliensis Yin, Tang & Xu, 2003	*Heptathela*	—	—	*Heptathela*	*Heptathela*
cipingensis Wang, 1989	*Liphistius*	*"Songthela"*	*Liphistius*	*Heptathela*	*Heptathela*
cucphuongensis Ono, 1999	*Heptathela*	*"Vinathela"*	*Heptathela*	*Heptathela*	*Heptathela*
goulouensis Yin, 2001	*Heptathela*	—	*Heptathela*	*Heptathela*	*Heptathela*
hangzhouensis Chen, Zhang & Zhu, 1981	*Heptathela*	*"Songthela"*	*"Sinothela"*	*"Songthela"*	*Heptathela*
heyangensis Zhu & Wang, 1984	*Liphistius*	*"Abcathela"*	*"Sinothela"*	*"Songthela"*	*Heptathela*
higoensis Haupt, 1983[1]	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
hongkong Song & Wu, 1997	*Heptathela*	*"Vinathela"*	*"Nanthela"*	*"Nanthela"*	*Heptathela*
hunanensis Song & Haupt, 1984	*Heptathela*	*"Vinathela"*	*Heptathela*	*Heptathela*	*Heptathela*
jianganensis Chen, Gao, Zhu & Luo, 1988	*Heptathela*	*"Abcathela"*	*Heptathela*	*Heptathela*	*Heptathela*
kanenoi Ono, 1996	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
kikuyai Ono, 1998	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
kimurai Kishida, 1920	*Liphistius*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
luotianensis Yin, Tang, Zhao & Chen, 2002	*Heptathela*	—	—	*Heptathela*	*Heptathela*
mangshan Bao, Yin & Xu, 2003	*Heptathela*	—	—	*Heptathela*	*Heptathela*
nishikawai Ono, 1998	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
nui sp. n.	*Heptathela*	—	—	—	*Heptathela*
sapana Ono, 2010	*"Abcathela"*	—	—	*Heptathela*	*Heptathela*
schensiensis Schenkel, 1953	*Liphistius*	*"Abcathela"*	*"Sinothela"*	*"Songthela"*	*Heptathela*
shei Xu & Yin, 2001	*Heptathela*	-	*Heptathela*	*Heptathela*	*Heptathela*
sinensis Bishop & Crosby, 1932	*Heptathela*	*"Abcathela"*	*"Sinothela"*	*"Songthela"*	*Heptathela*
suoxiyuensis Yin, Tang & Xu, 2003	*Heptathela*	—	—	*Heptathela*	*Heptathela*
tomokunii Ono, 1997	*Heptathela*	—	*Heptathela*	*Heptathela*	*Heptathela*
tonkinensis Bristowe, 1933	*Liphistius*	*"Vinathela"*	*"Nanthela"*	*"Nanthela"*	*Heptathela*
wosanensis Wang & Jiao, 1995	*Heptathela*	—	—	*Heptathela*	*Heptathela*
xianningensis Yin, Tang, Zhao & Chen, 2002	*Heptathela*	—	—	*Heptathela*	*Heptathela*
yaginumai Ono, 1998	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
yakushimaensis Ono, 1998	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
yanbaruensis Haupt, 1983[1]	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*	*Heptathela*
yunnanensis Song & Haupt, 1984	*Heptathela*	*"Abcathela"*	*Heptathela*	*Heptathela*	*Heptathela*

been settled by Foelix & Erb (2010a: 7-8, fig. 10; 2010b), who show that extant mesothelid spiders (at least females and juveniles) have venom glands. In liphistiid spiders the venom probably does not play an important role during prey capture. Upon seizing prey, the spiders almost immediately start crushing it with their strong and unusually mobile chelicera, which can be spread at a right angle to each other. *Liphistius* bites to one of us (PJS) had no recognizable toxic effects.

2) He also stated that "the moulting specimen turns round and lies on its back for the moulting process ..." (Haupt, 2003: 49-50, 95), in the same way as theraphosid spiders do, and he concludes "As this turning for moulting does not occur in other Megoperculata ... it seems to be an autapomorphic habit characteristic of Araneae" (Haupt, 2003: 50). This is not the case. Haupt was presumably generalizing from a single observation captured in a photo (Haupt, 2003: fig. 35D) which shows the final moult of a *L. trang* Platnick & Sedgwick, 1984 male lying on its back. Looking at the exuvia in this photo, however, it becomes clear that the spider actually moulted in a venter-down position. When pulling the anterior limbs out of the old cuticle, the posterior legs obviously remained stuck in it. As the spider struggled to get free, both legs IV and one leg III (still soft and flexible) bent backwards and the spider fell on its back. The damage to the discarded exuvia seen in another photo (Haupt, 2003: fig. 35E), with the fourth pair of legs missing, clearly show that this was not a normal moult and that the spider's fourth pair of legs probably got permanently stuck in the exuvia. An examination of this specimen in Haupt's collection should confirm our interpretation. We have had the chance to observe dozens of moults of liphistiid spiders in captivity, and we have collected hundreds of exuviae in the field and in captivity. In all cases the exuviae were in a venter-down position, with the leg claws and palpal claws gripping the substrate (Figs 65-66). In the interior of their burrows (in nature liphistiids always moult inside them) there is not enough space for the spiders to arch up and bend backward during moulting. They thus normally moult in the same position as uropygids and amblypygids.

Ectoparasitic mites: The same kind of mites, as were collected from the two *Heptathela* species in southern Vietnam (Figs 67-68 show bite marks), were also found on *Liphistius* at several localities in Laos, Thailand and peninsular Malaysia. At one locality in eastern Thailand the majority of liphistiid spiders collected were carrying mites. They stay on their hosts permanently and pierce the hard carapaces and chelicerae but not the soft membranes. These mites were identified as belonging to the laelapid genus *Ljunghia* and are currently being studied by I. Juvara-Bals & B. Halliday. *Ljunghia* includes obligate ectoparasites which naturally occur on primitive spiders in SE-Asia and Australia (Domrow, 1975), and which were also found on a Central American theraphosid spider in captivity (Moraza *et al.*, 2009). So far only one *Ljunghia* species associated with liphistiid spiders is known, *Ljunghia bristowi* (Finnegan, 1933) living on *Liphistius malayanus* in peninsular Malaysia (Finnegan, 1933). Further species, including the one living on *H. australis* and *H. nui* sp. n., will be described soon.

It appears worth pointing out that all *Heptathela* specimens from southern Vietnam that carried such mites were reproducing females that either laid eggs (3 *H. australis*) or were gravid (1 *H. nui* sp. n.). No mites were seen on juveniles or mature

FIGS 65-66

Liphistius sumatranus Thorell, 1890, moulting of an immature male in captivity. (65) Spider partly emerged from the old cuticle. (66) Spider fully emerged. Note that the animal does not lie on its back.

FIGS 67-68

Dorsal view of prosomata of two females showing bite marks caused by ectoparasitic *Ljunghia* mites. (67) *Heptathela australis* (Ono, 2002); chelicerae spread due to preservation. (68) *H. nui* sp. n., paratype; chelicerae in normal position.

males. This may just be a coincidence, because in *Liphistius* such mites were also found on females that did not reproduce in captivity, and on immature and mature males (unpublished observation).

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A new genus and species of Spilomelinae (Lepidoptera, Pyralidae) from the Galapagos Islands, Ecuador

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A new genus and species of Spilomelinae (Lepidoptera, Pyralidae) from the Galapagos Islands, Ecuador. - *Cheverella galapagensis* Landry, gen. n. and sp. n. is described as an endemic of the Galapagos Islands, Ecuador. Based on a combination of two apomorphies (reduced uncus and presence of setose pads on anterodorsal extensions of the male valva medially) this taxon is possibly related to *Choristostigma* Warren, now placed in the *Hydriris* group of Munroe (1995), but *Cheverella* lacks the setose projection at base of the valve's costa present in *Choristostigma*. The female has a clearly circumscribed corpus bursae with a short, spine-like signum. *Cheverella* also shares a few characters with members of the *Siga* group. The larva is a borer in stems of the endemic *Tournefortia pubescens* Hook. *f.* (Boraginaceae).

INTRODUCTION

During his first expedition to the Galapagos in 1989 at the onset of his inventory of the Lepidoptera of the archipelago, B. Landry (BL) came across the nicely patterned pyraloid treated here, and began to investigate its generic affinities. The double praecinctorium pointed to a Spilomelinae, and along the years since 1989 the species was shown to several colleagues (James Hayden, Eugene Munroe, Matthias Nuss, Michael Shaffer, Alma Solis), who concluded that it was undescribed and that it did not belong to any described genus, while various proposals were made with regard to phylogenetic affinity to other genera. In 1983, Eugene Munroe had, in fact, examined a specimen preserved in the Museum of Comparative Zoology, Cambridge, Massachusetts, and added a label saying 'New Pyraustine', a group which at the time included the Spilomelinae.

Here this new taxon is finally described. Its recognition will allow for an evaluation of its conservation status and to plan future studies on its ecology.

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With more than 3700 species described, the Spilomelinae is one of the two largest subfamilies of the Pyraloidea, a group including either one (Pyralidae) or two (Crambidae and Pyralidae) families, depending on authors. It is included in the monophyletic group of pyraloid subfamilies here referred to as Crambiformes (the Crambidae, or Crambinina), the other group of subfamilies being known as Pyralidae s. str., or Pyralinina, or Pyraliformes. Munroe (1995) treated the subfamily as a tribe of Pyraustinae and recorded 1437 species in the Neotropical Region. The Spilomelinae are believed to be polyphyletic (Minet, 1982; Solis & Maes, 2003), but this has never been tested. The moths are characterized by the absence of chaetosemata, a bilobed praecinctorium, a projecting fornix tympani (tympanic frame), a pointed spinula, the absence of a gnathos, and the absence of a rhomboidal signum on the bursa copulatrix of the female genitalia (Minet, 1982; Nuss *et al.*, 2011). Other diagnostic characters are the loss of the subcostal hamus (frenulum hook) on the male forewing and the male valva with a clasper in some other conformation than in Pyraustinae (Munroe, 1976: 8). When *Cheverella* is compared with the matrix and characters used by Solis & Maes (2003) in their phylogenetic analysis of the crambiforme subfamilies, the genus scores as a representative of the Spilomelinae for all 17 characters used, although the shape of the median ridge of the tegumen is here complete from base to apex, not u-shaped at base.

In the Galapagos Islands, there are 42 species of Spilomelinae currently known, of which nine are undescribed and under investigation (BL, unpublished).

MATERIAL AND METHODS

Specimens were collected mostly by BL at light during five expeditions to all of the major islands of the Galapagos in 1989, 1992, 2002, 2004, and 2005. The 1989 material was deposited at the Canadian National Collection of Insects, Ottawa, Canada (CNC) while most of the rest is deposited in the Muséum d'histoire naturelle, Geneva (MHNG). Many valuable specimens, including the single reared specimen came from co-author L. Roque-Albelo while he worked at the Charles Darwin Research Station, on Santa Cruz Island, Galapagos (CDRS). Additional material came from the California Academy of Sciences, San Francisco, California, USA (CAS), the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA (MCZ), and the Natural History Museum, London, U.K. (BMNH).

The terminology of the tympanal organs follows Landry (1995). That of genitalia follows Solis & Maes (2003). The manner of giving the label data of the holotype and paratypes is presented in Landry (2006) as are the methods used for specimen collecting.

DESCRIPTIONS

Cheverella Landry gen. n. Figs 1–8

Type species: *Cheverella galapagensis* sp. n.

Gender: feminine.

DIAGNOSIS: *Cheverella* can be separated from the other genera of Spilomelinae by two apomorphies of the male genitalia, i.e. the reduced uncus and the presence of

FIGS 1-2

Cheverella galapagensis Landry, sp. n. (1) Holotype (CNC). (2) Darker coloured female paratype (MHNG).

setose pads on anterodorsal extensions of the valva mediobasally, and the clearly circumscribed corpus bursae with a short, spine-like signum in the female. *Choristostigma* Warren, a mainly North American genus with nine species, also has a reduced uncus and setose pads on a transtilla or extensions of the valva as in *Cheverella* (*C. elegantalis* Warren and *C. plumbosignalis* (Fernald) examined), but its valva is more narrow and it has a short, setose projection at base of costa. The female genitalia of *Choristostigma* (*C. plumbosignalis* (Fernald) examined) differ more strongly in that the wide ductus bursae has a large colliculum, the papillae anales are elongate rather than triangular, and the signum is very large, oval, and with multiple spines that are 4-5 X longer than their basal width and irregularly distributed.

DESCRIPTION: Head (Fig. 3) with antennae filiform, slightly thinner in female, reaching almost 2/3 of length of forewing, with dense, short ciliation ventrally, with single short seta arising from scale-coated dorsal edge near middle of first 12 flagellomere approximately, with last flagellomere terminating into distinct sensillum styloconicum; with ocelli; without chaetosemata; maxillary palpus very short; labial palpus curved upward at about half right angle, reaching slightly above eye.

Forewing rather narrow, 2.4 X longer than largest width. Frenulum simple in male, with 2 acanthae in female. Retinaculum a short bunch of scales below cubital stem; male without frenulum hook. Wing venation (n=1) (Fig. 4): Forewing Sc, R1, and R2 free, latter from before upper angle of cell; R3 and R4 stalked for most of length, stemming from upper angle of cell; R5, M1-3, and CuA1-2 veins free; M1 and M2 well separated at base; M3 from lower angle of cell; 1A+2A clear; 3A faintly indicated. Hindwing with Sc+R1 connected with Rs from 1/2 to 3/4; M1-3, and CuA1-2 veins free; M1 and M2 well separated at base; M2, M3 and CuA1 stemming from lower angle of cell; anal veins clearly distinct. Abdomen: Male intersegmental membrane VIII-IX without associated sclerites or hair-like scales. Sternum VIII broadly sclerotized at base, with short median extension and long, thin lateral extensions reaching apex; tergum VIII with broad sclerotized band along whole segment medially. Female segment VII well sclerotized, narrower and longer than preceding segment, with tergum a large quadrangular plate. Tympanal organs (n=6) (Fig. 5): Tergo-sternal sclerite with broadly rounded, deeply concave ventral margin.

Tympanum plane almost at right angle from sternal plane. Tympanic frame slightly projecting ventrad of margin of segment. Tympanic crest short, situated slightly anterad of middle. Tympanic drum short, slightly longer than wide, extending anterad to base of bridge. Transverse ridge slightly concave medially, without tympanic pockets, or unapparent, blending with surface of sternum. Tympanic bridge about 1/3 length of drums. Praecinctorium only slightly bilobed.

Male genitalia (n=3) (Figs 6, 7). Tegumen with wide median ridge, narrowly extended laterally at apex, widened at base and narrowly connected with lateral ridges; area between median and lateral ridges more thinly sclerotized, slightly bulged and with scale sockets, as opposed to bare ridges. Uncus reduced, mostly thinly sclerotised, rounded, apically setose, occasionally with very short median depression dorsally; ventral margin more thickly sclerotized, occasionally with very tiny point medially. Short arms of gnathos (sensu Solis & Metz, 2011) fused with narrow apicolateral ridges of tegumen, narrowly triangular, not connecting medially. Dorsal articulation of valva with vinculum of adjacent type (see Solis & Maes, 2003). Costa of valva with medially directed projection posterad of dorsal articulation of valva with vinculum; projections not connected medially and supporting rounded setose pads ventrally. Valva short, narrowing to half basal width near middle, apically rounded, with digit-like, mediodorsally recurved projection (sella) medially between pair of ridges, with shallow rounded cavity ventrad of sella, with long, abundant setation on basal part of sella dorsally. Juxta a thin, elongate plate with lobed ventral and apical margins, with short wing-like extensions laterally before middle. Vinculum shorter than tegumen + uncus, narrow, with anterior end curved upward, apically blunt in lateral view. Phallus short, stout, without pronounced coecum penis; vesica with bunch of about 20 short, slender cornuti.

Female genitalia (n=3) (Fig. 8). Papillae anales simple, rounded, setose, unconnected dorsally, with straight sclerotized band at base. Apophyses posteriores straight, reaching middle of segment VIII. Latter with well sclerotized plates laterally, sparsely setose, expanding apicoventrally toward midline, but medially not connected, dorsally approximate on distal half and fused on proximal half. Apophyses anteriores slightly curved and longer than posterior ones, not quite reaching middle of segment VII. Lamella postvaginalis triangular, located at base and between apical ventral extensions of sclerotized plates of segment VIII. Ostium bursae at bottom of cup-like, thinly sclerotized antrum. Ductus bursae with girth about 1/3 width of middle of antrum, more or less ridged on distal half, proximal half gradually expanding, without colliculum. Ductus seminalis arising subdistally, at slightly less than 1/3 of length of ductus bursae from ostium. Corpus bursae circular, with one small, spine-like signum ventrally near distal end.

ETYMOLOGY: The name is derived from a frequent interjection heard in Ecuador, *chévere*, which means great, nice, or cool. The unusual maculation of the moth prompted this interjection, or a synonym, to me and others who examined it. This type of maculation is found in another species of Galapagos Spilomelinae, but not in any other members of this subfamily as far as we know.

BIOLOGY: The caterpillar of *Cheverella galapagensis* is a borer in stems of *Tournefortia pubescens* Hook. *f.* (Boraginaceae). One moth was reared by Lazaro

FIG. 3
Cheverella galapagensis Landry, sp. n. Head of paratype female from Santa Cruz Island (CNC).

Roque-Albelo in 1999, from a plant growing on the Barranco, just behind the Charles Darwin Research Station on Santa Cruz Island. This endemic species of *Tournefortia* is known to contain pyrrolizidine alkaloids (Roque-Albelo *et al.*, 2009). These are known to protect *Utetheisa connerorum* Roque-Albelo & Landry (Lepidoptera, Arctiidae) (formerly mostly known as *U. galapagensis* (Wallengren)) moths from being consumed by *Eustala* (Araneidae) spiders (Garrett *et al.*, 2008). Whether or not *Cheverella* also stores pyrrolizidine alkaloids remains to be discovered.

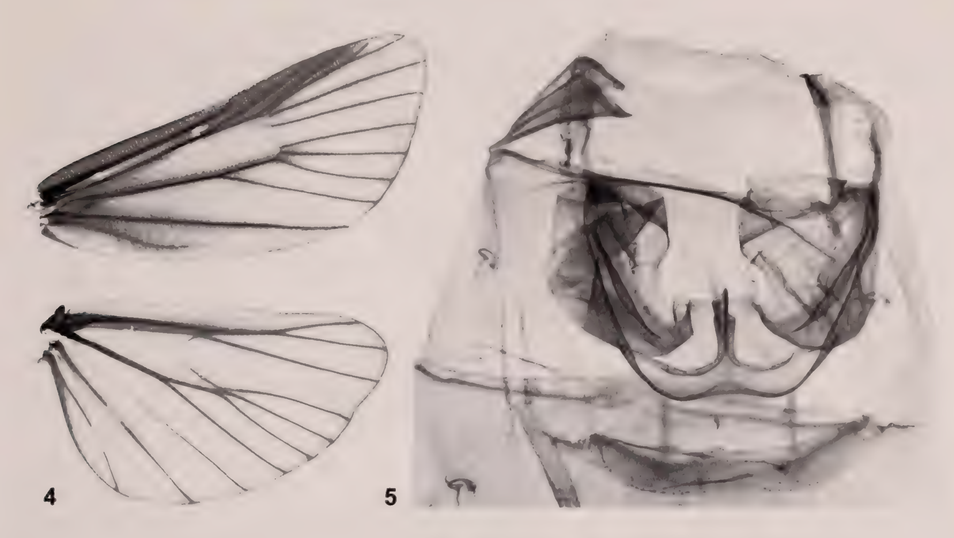
REMARKS: The medially directed projections arising from the costal edge of the valvae posterad from the dorsal articulations of the valvae with the vinculum are not called a transtilla as the definition of this structure is restricted to 'the [dorsal] sclerotisation of the diaphragma' (Solis & Maes, 2003).

SYSTEMATIC POSITION: The current classification of Neotropical Spilomelinae (Munroe, 1995) recognizes 14 groups of genera and 51 unplaced genera. Unfortunately, Munroe did not provide diagnostic characters to support his groups, and there is no classification available for any other Spilomelinae fauna. Therefore, we examined representatives of Munroe's generic groups to find apparently diagnostic character combinations, and we comment on their validity and applicability to the newly described genus. *Cheverella* was found to have affinities with the *Hydriris* and

the *Siga* groups of Munroe (1995). With the Hydriris group, *Cheverella* shares a reduced uncus without robust bifid spines and the presence of setose pads in the vicinity of the transtilla in *Choristostigma* Warren. However, in the other genera of the group, the setose pads are in different positions (on the costa in *Geshna* Dyar, on the tegumen in *Hydriris* Meyrick) or absent in *Nehydriris* Munroe. Most of the members of this group share tufts of setae at or around the base of the costa of the valva, but these setae are lacking in *Cheverella* and *Nehydriris*, and the female genitalia vary among the three genera for which they are known. The Diagnosis above explains some of the differences between the female genitalia of *Cheverella* and *Choristostigma*. Those of *Geshna* show a poorly differentiated, elongate corpus bursae without signum, while those of *Hydriris* have a very short ductus bursae and an elongate corpus bursae with an appendix bursae and with two large signa showing about 12 long, thin and curved projections. The labial palpi are variable. They are upturned in *Hydriris* and *Geshna* but porrect with downturned apical meron in *Choristostigma*, so the upwardly directed palpi of *Cheverella* fit in this range. Hence, there is no clear indication that the *Hydriris* group is monophyletic as presently constituted.

The *Siga* group of Munroe (1995) comprises large, robust-bodied Neotropical moths. Our concept of the group is here informed by our addition of *Loxomorpha* Amsel and *Maracayia* Amsel, because they share the same structural characters and known larval habits, despite their much smaller size. So defined, the *Siga* group varies greatly in maculation, but the forewing postmedial line is usually roundly concave on the anal fold. The labial palpi are short or obliquely ascending with a short apical meron. The male genitalia are robust with a moderately inflated sacculus and well-sclerotized costa, and the saccus is absent or weakly developed. The sella is aciculate in most member taxa (as in the *Hydriris* group), but it is quadrate in some (*Cirrhocephalina* Munroe) or with a basal process (*Laniifera* Hampson). The uncus is bifid with a short stalk or none at all (with the two uncus arms arising from the tegumen separately), and the apices of the uncus are armed with robust, bifid chaetae. In the female genitalia, where known, the ostium bursae is strongly sclerotized and shaped like a funnel or pitcher plant, and the corpus bursae lacks a signum. Known larvae (*Laniifera*, *Beebea* Schaus, *Loxomorpha*, *Maracayia*) are all borers in Cactaceae. Among these characters, *Cheverella* shares the straight and obliquely ascending labial palpi, robust genitalia with inflated sacculus, and the distally quadrate sella of some members. The breadth of the ostium bursae is similar, but it is only weakly sclerotized in *Cheverella*. The absence of an uncus, bifid or otherwise, would be explained as derived from the reduced bilobate condition seen in *Zeuzerobotys* Munroe. Although *Cheverella* is much smaller than most, it is comparable in size to *Loxomorpha* species. The black and white wing coloration is shared with *Zeuzerobotys*.

The following characters are shared by the two groups and *Cheverella*, so although they do not favor placement in either group, they exclude *Cheverella* from many other spilomeline groups. The valve costa is straight or slightly concave, and the apex of the valve is rounded but attenuate (narrower than the valve width across the costa). The valve sella originates variably from the costal half of the valve or near middle of the valve. The hindwing maculation is nearly absent, and the praecinctorium is weakly (not strongly) bilobed.



FIGS 4-5

(4) *Cheverella galapagensis* Landry, sp. n. Wing venation of paratype male (MHNG). (5) *Cheverella galapagensis* Landry, sp. n. Tympanal organs of paratype male, without praecinctorium (MHNG).

Other characters were examined (tympanal organs, venation) but were found to be either invariant or so variable as to be uninformative of relationships at the level of generic group. The diagnostic characters in these groups (and others) should be evaluated in a phylogenetic context to determine their influence and to help uncover the relationships of *Cheverella*.

The biogeographic relationships of *Cheverella* are ambiguous but suggest testable hypotheses. The *Hydriris* group includes one Neotropical member (*Nehydriris* of southern Brazil) and the cosmopolitan *Hydriris*; the other members range to the southern Nearctic. As far as known, the *Siga* group is exclusively Neotropical to southern Nearctic, with members distributed in many subregions. Among these, *Beebea guglielmi* Schaus is endemic to the Galapagos Islands, so despite the great difference in body size and maculation, the possibility of a close relationship should be considered. If *Cheverella* belongs to the *Siga* group, two hypotheses suggest themselves. A close relationship with *Beebea* would support rapid evolutionary divergence in body size and wing maculation, which might be expected on the Galapagos. Conversely, a closer relationship with a mainland taxon would suggest more than one dispersal event to the islands or a more complex biogeographic scenario. If *Cheverella* is more related to some other spilomeline group, similarly intriguing hypotheses may present themselves. Cladistic and biogeographic analyses of Spilomelinae are greatly needed for choosing among these alternative hypotheses.

Cheverella galapagensis Landry, sp. n. Figs 1–8

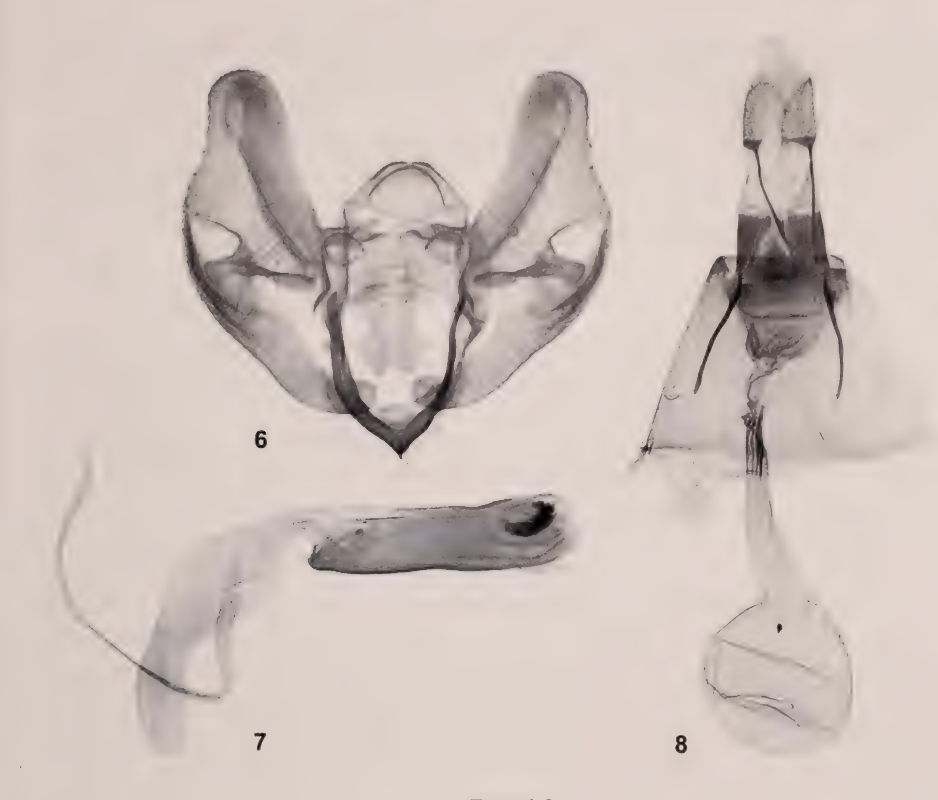
MATERIAL EXAMINED: Holotype male: 1- 'ECUADOR | GALÁPAGOS | Santa Crúz | Los Gemelos | 31.I.1989, M[ercury]V[apour]L[ight] | B. Landry' [printed in black ink on white card stock, with 'ECUADOR' sideways on left]; 2- 'HOLOTYPE | Cheverella | galapagensis | B. Landry' [hand-written in black ink on red card stock]. Deposited in the CNC.

PARATYPES: 26 ♂, 49 ♀, 1 of unknown sex from the Galapagos Islands, Ecuador: – *Fernandina*: 1 ♂, SW side, crater rim, G[lobal]P[ositioning]S[system]: 1341 m, S 00° 21.910', W 091° 34.034', 12.ii.2005, u[ltra-]v[iolet]l[ight] (B. Landry, P. Schmitz). – *Isabela, Alcedo*: 1 ♀, Lado Este, 700 m elev[ation]., 6.iv.1999, uvl-f[?].l[ight] (L. Roque); 1 ♂, 1 ♀, NE slope, about 400 m up (S) Los Guayabillos camp, GPS: 892 m elev., S 00° 25.208', W 91° 04.765', 1.iv.2004, uvl (B. Landry, P. Schmitz); 1 ♂, 1 ♀ (DNA voucher, Lepidoptera, M. Nuss 2007, no. 263), lado NE, 400 m [elev.], camp pega-pega, 15.iv.2002, uvl (B. Landry, L. Roque); 2 ♂, 1 ♀, 570 m elev., 11.x.1998, uvl (L. Roque). – *Isabela, Sierra Negra*: 3 ♂, 11 km N P[uer]to Villamil, 13.iii.1989, M[ercury]V[apour]L[ight] (B. Landry); 1 ♀, same locality, G[lobalP[ositioning]S[system]: S 00° 87.613' [sic], W 91° 0.903', 9.iv.2004, uvl (P. Schmitz); 1 ♀, San[to] Tomas, 1200 F[ee]t. Alt[itude]., 22.viii.1906 (F. X. Williams); 1 ♂, 1 ♀, Alemania, xi.1974 (T.J. de Vries); 2 ♀, Corazon Verde, xi-xii.1974 (T.J. de Vries). – *Isabela, Volcan Darwin*: 1 ♂, 300 m elev., 15.v.1992, MVL (B. Landry); 1 ♂, 630 m elev., 16.v.1992, MVL (B. Landry); 1 ♂ (dissected, slide MHNG ENTO 6070), same data except 17.v.1992; 2 ♂ (one dissected, slide MHNG ENTO 3041), 300 m elev., 20.v.1992, MVL (B. Landry). – *San Cristobal*: 1 ♀ (dissected, slide CNC PYR 366), pampa zone, 18.ii.1989, MVL (B. Landry); 1 ♀, La Toma, ca. 5.6 km East El Progreso, GPS: 299 m elev., S 00° 55.356', W 089° 31.089', 23.ii.2005, uvl (B. Landry). – *Santa Cruz*: 1 ♀, C[harles]D[arwin]R[esearch]S[tation], arid zone, 19.i.1989, MVL (B. Landry); 1 ♀, 4 km N Puerto Ayora, 20.i.1989, MVL (B. Landry); 4 ♀, Media Luna, pampa zone, 21.i.1989, MVL (B. Landry); 2 ♂, 1 ♀, same data as holotype; 1 ♂, C[harles] Darwin Res[earch]. Sta[tion]., alt. ± 5 m, 2.ii.1970, at u.v. "blacklight" (R. Silberglied); 1 ♂, Tortuga Res[erve]., W S[an]ta Rosa, 6.ii.1989, MVL (B. Landry); 1 of sex unknown, Media Luna, pampa zone, 8.ii.1989, MVL (B. Landry); 1 ♀, Horneman Farm, 220 m, 16.ii.1964 (D. Q. Cavagnaro); 1 ♀, same data except 25.iii.1964; 1 ♀, same data except 30.iii.1964; 3 ♀, same data except 5.iv.1964; 2 ♀, same data except 3.v.1964; 1 ♀, same data except 7.v.1964; 1 ♀, 2 km W Bella Vista, 27.ii.1989, MVL (B. Landry); 1 ♂, Academy Bay, Darwin Research Sta[tion]., 27.ii.1964 (D. Q. Cavagnaro); 1 ♂, 3 ♀, [no precise locality], iii.1969, B.M. 1970-172, Ref. No. L.80 (no collector); 1 ♀, E[stacion]C[ientifica]C[harles]D[arwin]., 6.iii.1992, uvl (B. Landry); 1 ♂ (dissected, slide MHNG ENTO 6069), transition zone, recently cut road, GPS: S 00° 42.528', W 90° 18.849', 12.iii.2004, uvl (B. Landry, P. Schmitz); 1 ♀, low agriculture zone, GPS: S 00° 42.132', W 90° 19.156', 13.iii.2004, uvl (B. Landry, P. Schmitz); 1 ♀, Finca S[teve]. Devine, 17.iii.1989, MVL (B. Landry); 1 ♂, grassland, 750 m, 6.iv.1964 (D. Q. Cavagnaro); 1 ♂, vic[inity]. "Mirador", W of Media Luna, alt. ± 620 m, 26.v.1970 (Silberglied); 4 ♀ (one dissected, slide MNHG ENTO 6068), Los Gemelos, 27.v.1992, MVL (B. Landry); 2 ♀, Station Darwin, lumière, x.1964 (J. & N. Leleup); 2 ♀, Hacienda Schiess., xi.1974, B.M. 1975-7, Ref. No. L (no collector); 1 ♂, CDRS, Barranco, barrenador de tallos [de] Tournefortia pubecens [sic], emergio 17.xi.1999 (L. Roque); 1 ♀, 80 [referring to note in notebook of ?T. J. de Vries, deposited at CDRS]. – *Santiago*: 1 ♀, N side, GPS: 527 m elev., S 00° 13.690', W 90° 44.135', 5.iii.2005, uvl (P. Schmitz); 1 ♀, Aguacate [camp], 520 m elev., 6.iv.1992, MVL (B. Landry); 3 ♀, Central [camp], 700 m elev., 9.iv.1992, MVL (B. Landry); 1 ♂ (wings on slide MHNG ENTO 3043), 1 ♀, Aguacate, 520 m elev., 12.iv.1992, MVL (B. Landry). Deposited in the BMNH, CAS, CDRS, CNC, MCZ, and MHNG.

ETYMOLOGY: From the name of the archipelago where this species is presumably endemic.

DIAGNOSIS: Currently unique within the genus *Cheverella*, this species can be separated from presumably related taxa as mentioned in the generic diagnosis above. In the Galapagos, this species is unique by virtue of its whitish grey colour with deep dark brown markings on the forewing, head, and thorax. An undescribed species of endemic *Agathodes* Guenée (Pyralidae, Spilomelinae) has a similar colour and pattern, but its wings are narrower and longer, and its hindwing is completely suffused with brown, with a light purple shine.

DESCRIPTION: MALE (n=27) (Fig. 1). Head white with greyish brown as spot between antennae, and ventrally behind eyes. Antenna white, with brown on basal



FIGS 6-8

Cheverella galapagensis Landry, sp. n. Male genitalia of paratype (MHNG). (6) Genitalia without phallus. (7) Phallus. (8) *Cheverella galapagensis* Landry, sp. n. Female genitalia of paratype (CNC).

flagellomeres. Haustellum and maxillary palpus white. Labial palpus mostly white, brown laterally on palpomeres II and III. Thorax white with brown spots as shown, deeper brown (almost black) at collar, greyish brown on metascutellum. Foreleg with greyish brown on dorsal side, white ventrally; midleg white with brown at tips of femur and tibia; hindleg entirely white. Forewing white with deep dark brown spots and lines as shown, sometimes (1 specimen) with more extensive dark brown suffusion, especially between subapical line and outer margin. Forewing length 6.4–9.6 mm (holotype 8.7 mm). Hindwing white with more or less strongly marked subapical and apical lines, except in anal sector. Abdomen mostly white, with some greyish brown dorsally on all or most segments.

Male genitalia: See generic description.

FEMALE (n=49) (Figs 2, 3, 8). Forewing length 7.7–10.3 mm. Female genitalia: See generic description.

REMARKS: As mentioned above, L. R.-A. reared the only known larva from the host plant *Tournefortia pubescens* Hook. *f.* (Boraginaceae). This taxon is endemic to the Galapagos and found on the islands of Fernandina, Floreana, Isabela, Pinzon, San

Cristobal, Santa Cruz, Santiago, and Wolf (McMullen, 1999). Thus, the moth may also occur on the islands of Floreana, Pinzon, and Wolf, where adults have not yet been collected.

The latitude and longitude data of the specimen collected on Sierra Negra, Isabela, 11 km north of Puerto Villamil, on 9 April 2004 by P. Schmitz were taken in decimal degrees shown above in degrees, minutes, and seconds. In degrees with decimal minutes these data correspond to S 0° 52.568, W 91° 05.418.

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A new species of *Anthrenus* Geoffroy, 1762 (Coleoptera: Dermestidae) from Oman, with a key to related species

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A new species of *Anthrenus* Geoffroy, 1762 (Coleoptera: Dermestidae) from Oman, with a key to related species. - *Anthrenus (Anthrenus) ardoi* sp. n. from Oman is described. The habitus, antennae, and male genitalia are illustrated and compared to related species. The new species is characterized by eye with median side broadly and deeply emarginated at about anterior 1/3, 11-segmented antenna and broadly oval scales of the dorsum. Elytra covered with oval white patch on each side of the suture at its base, with three white, transverse, irregularly interrupted patches. The new species is most similar to *Anthrenus* (s. str.) *namibicus* Háva, 2000 and *A.* (s. str.) *flavipes flavipes* LeConte, 1854. Identification features to externally similar species of the genus are given. The most distinctive taxonomic characteristics concern the tibiae, the male genitalia and the 9th abdominal sternite are also given.

Keywords: Coleoptera - Dermestidae - *Anthrenus* - new species - taxonomy - morphology - comparative study - key - Oman.

INTRODUCTION

Genus *Anthrenus* is one of the 57 genera within the family Dermestidae (Háva 2007, 2010), and is characterized by the presence of scales covering almost a whole body. The scales often create colorful and very useful in identification patterns on the dorsum, and on the visible abdominal ventrites I-V. Currently genus includes 220 species, grouped in 10 subgenera (Háva 2003, 2008). Most of the species have been described from Palearctic and Afrotropical regions. Only five species have been recorded from Oman (Háva 2007, 2010). Two of them are members of the subgenus *Anthrenops* Reitter, 1881 (*A. cervenkai* Háva & Herrmann, 2006, *A. coloratus* Reitter, 1881), one of the subgenus *Anthrenodes* Chobaut, 1898 (*A. malkini* Mroczkowski, 1980), another one of *Anthrenus* s. str. (*A. flavipes flavipes* LeConte, 1854) and the last one of *Nathrenus* Casey, 1900 (*A. jakli* Háva, 2001). In the material from Oman studied recently we have found specimens representing a new species of the nominotypical subgenus. Its description is given below.

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MATERIAL AND METHODS

The following abbreviations to measurements were made:

total length (TL) - linear distance from anterior margin of pronotum to apex of elytra.
pronotal length (PL) - maximum length measured from anterior margin to posterior margin.
pronotal width (PW) - maximum linear transverse distance.
elytral length (EL) - linear distance from shoulder to apex of elytron.
elytral width (EW) - maximum linear transverse distance.

The following abbreviations are used in the text:

IZDBET Institute of Zoology, Department of Biodiversity and Evolutionary Taxonomy, Wrocław, Poland.
JHAC Private Entomological Laboratory & Collection, Jiří Háva, Prague-west, Czech Republic.
MZLU Lund University, Lund, Sweden.
NHMW Naturhistorisches Museum, Wien, Austria.
MHNG Muséum d'Histoire Naturelle, Geneva, Switzerland.
OXUM Oxford University Museum of Natural History, England.

Locality labels are cited in the original version. Separate labels are indicated by a slash (/). Author's remarks are in square brackets [ ].

Specimens have been labeled with red printed label of the following text: "HOLOTYPE [or PARATYPE, respectively] *Anthrenus* (*Anthrenus*) *ardo*i n. sp.".

Morphological structures were cleared in boiling 10% KOH solution, rinsed in distilled water, mounted in glycerin, and then examined, measured, and illustrated under a Nikon Eclipse E 600® phase contrast microscope. External structures were examined under a Nikon SMZ-800® stereoscopic microscope. The dissected parts were placed with glycerin in a plastic microvial and attached to the pin of the specimen. Photos were taken with a Canon 500D® and a Nikon Coolpix 4500®.

Terminology: The terminology used in this paper follows Beal (1998) and Lawrence & Ślipiński (2010), distribution and classification follows the world catalogue of Háva (2010).

SYSTEMATIC PART

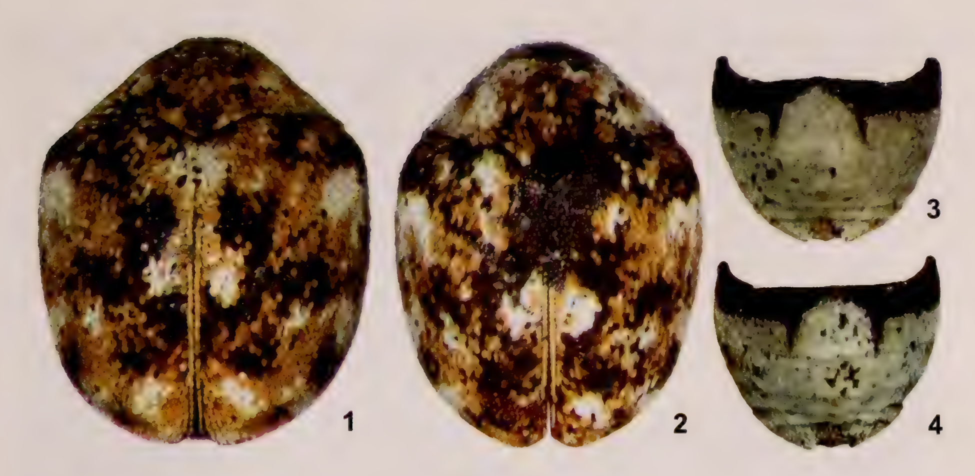
Megatominae Leach, 1815
Anthrenini Casey, 1900
Anthrenus Geoffroy, 1762

Anthrenus (Anthrenus) ardoi sp. n. Figs 1-9

MATERIAL STUDIED: Holotype (♂): Oman, Ghuzyan rd. Al Khabural-liberi 10.IV.1985 leg. Paul Ardö (MZLU). Allotype (♀): Oman, Yiti Wadi 7.IV.1985 Paul Ardö (MZLU).

Paratypes (16 exx. not sexed): (2 exx.) the same datas as holotype (1 MZLU, 1 JHAC); (8 exx.) the same data as allotype (5 MZLU, 1 MHNG, 1 IZDBTE, 1 JHAC); (5 exx.) Oman, Al Sinain, 10.IV.1985, leg. Paul Ardö (4 MZLU, 1 JHAC); (1 ex.) Oman, Nizwa, 12.IV.1985 leg. Paul Ardö (MZLU).

ETYMOLOGY: The epithet is a patronym honoring Dr. Paul Ardö (NHMW), who collected the type series material.



FIGS 1-4

Anthrenus (*Anthrenus*) *ardoi*. (1) Habitus, dorsal aspect (holotype, male). (2) Habitus, dorsal aspect (allotype, female). (3) Visible abdominal ventrites I-V (holotype, male). (4) Visible abdominal ventrites I-V (allotype, female).

DIAGNOSIS: The new species can be differentiated from some of the species occurring in Oman by the:

1) The total number of antennomeres: in *A. ardoi* antennae with eleven antennomeres; in *A. cervenkai* Háva & Herrmann, 2006 and *A. coloratus* Reitter, 1881 with nine antennomeres; in *A. malkini* Mroczkowski, 1980 with ten antennomeres.
2) The morphology of eye: in *A. ardoi* eye with median side broadly and deeply emarginated at about anterior 1/3; in *A. cervenkai*, *A. coloratus* and *A. jakli* eye oval.

Due to variation in the dorsal setal pattern, the new species dorsal appearance resembles some forms of *Anthrenus* (s. str.) *namibicus* Háva, 2000 and *A.* (s. str.) *flavipes flavipes* LeConte, 1854 and can be easily confused with them. The distinction between these two species can be done based on the following characteristics:

1) In *A. ardoi* and *A. flavipes flavipes* tibial spines on first pair of legs absent; in *A. namibicus* present.
2) In *A. ardoi* claws of third pair of legs with one small denticle, in *A. flavipes flavipes* denticle not present; in *A. namibicus* three denticle present.
3) In *A. ardoi* apex of paramers slightly curved in to middle, paramers with apex and median lobe slender and narrower, median lobe with distinct extension in 1/2 of its length (Fig. 6); in *A. flavipes flavipes* and *A. namibicus*, although male genitalia are similar in general shape to *A. ardoi*, their parameres are broader; while in *A. namibicus* Háva, 2000 parameres are distinctly curved toward the middle, setae present only on apex of the parameres, median lobe with distinct extension in 3/5 of its length; in *A. flavipes flavipes* parameres are curved to ward the middle, setae present on apex and in the inner margin of parameres, median lobe without distinct extension.

4) In *A. ardoi* 9th abdominal sternite without distinct waist, with the same width throughout its length, the apex with cordate, deep indentation, sclerotization on the sides and only in the mid section of the upper part - extending to the top and underneath; in *A. flavipes flavipes* 9th abdominal sternite spatulate, with the apex narrow and flat, three times wider posteriorly than the apex width, distinct waist in a mid section present, sclerotization on the sides and the mid section only - extending underneath; in *A. namibicus* 9th abdominal sternite without distinct waist, with the same width throughout its length, the apex almost flat with slight and shallow indentation, sclerotization on the sides and only in the mid section of the upper part - extending to the top and underneath.

DESCRIPTION

Holotype male. *Body*: measurements (mm): TL 2.0 PL 0.6 PW 1.3 EL 1.4 EW 1.7 SL 1.1 SW 1.5. Body convex, rounded, integument brown, finely punctured, covered by broadly oval scales.

Scales: two times as long as width, their surface mostly with 14 complete, linear ribs; the apex of the scale is truncated or rounded and an apical lappet is not present (Figs 8-9).

Head: is characterized by large convex eyes. Eye with median side broadly and deeply emarginated at about anterior 1/3. Median ocellus present on the frons. Antennae with 11 antennomeres, with 3-segmented antennal club (Fig. 5); antennomeres dark-brown. Antenna occupies whole cavity of antennal fossa. Antennal club in both sexes occupies less than half length of the antenna, and is distinctly longer than length of two basal segments combined. Antennal fossa is completely open along lateral margin of the pronotum and occupies 1/3 of the length of lateral margin. Dorsal margin of antennal cavity not visible from above. Dorsal surface covered with white, light- and dark brown scales (Figs 1-2) as follows: *pronotum* with mixed and irregular light-dark brown and white scales; small white patch near lateral angles enclosing light brown patch.

Elytra: covered with one oval white patch on each side of the suture at its base, with three white, transverse, irregularly interrupted patches: first in basal third, second close the middle, and third in apical fourth or fifth. Dark brown patches are present near humeri, in the central part of disc close to suture, and in basal third near the lateral margin. The remaining areas between bands are covered with light brown scales mixed with single white scales.

Ventral surface: with all scales white except for visible ventrites II-V covered with mix of yellowish (light brown) and white scales; first abdominal ventrite has stria (Figs 3-4).

Legs: brown and covered with white scales on dorsal surface. Tibiae without tibial spines. Tarsus with two slightly curved claws. Claws of the third pair of legs with one small denticle in the half of its length.

Male genitalia: as in figure 6. Parameres are deeply U-shaped, covered with few short setae on the lateral margins as well as in the central and inner areas. Median lobe in lateral view straight, with a distal end of aedeagus pointing up; in the frontal

FIGS 5-9
Anthrenus (*Anthrenus*) *ardoi* (holotype). (5) Male antenna. (6) Male genitalia. (7) 9th abdominal sternite. (8-9) Scales.

view, wider posteriorly, with narrow apodemes which occupying 1/3 of median lobe length (Fig. 6).

9th abdominal sternite as in figure 7. Pygidium with sub-basal, transverse, dark, carina-like line.

OBSERVED VARIATIONS: The dorsal patterns vary in color intensity (either darker or lighter). White patches occupies bigger or smaller areas on the pronotum and elytra (Figs 1-2). Body measurements for allotype (female): TL 1.9 PL 0.6 PW 1.2 EL 1.4 EW 1.5 SL 1.0 SW 1.4; for paratypes varying from (mm): TL 2.7-3.3 PL 0.6-0.7 PW 1.4-1.6 EL 2.1-2.4 EW 1.9-2.4.

SHORT KEY TO THE RELATED SPECIES AND TO THE KNOWN *ANTHRENUS* SPECIES FROM OMAN:

1. Antenna with 10-11 antennomeres . . . . 2.
1a. Antenna with 9 antennomeres . . . . 3.
2. Antenna with 10 antennomeres . *A.* (*Anthrenodes*) *malkini* Mroczkowski, 1980
2a. Antenna with 11 antennomeres . . . . 4.
3. Antennal club with two antennomeres, male antennomere 9 at least 4x longer than antennomere 8 . . . . *A.* (*Anthrenops*) *coloratus* Reitter, 1881
3a. Antennal club with three antennomeres, male antennomere 9 at least 2.5x longer than antennomere 7 . . . . *A.* (*Anthrenops*) *cervenkai* Háva & Herrmann, 2006
4. Inner margin of eye emarginated . . . . 5.
4a. Inner margin of eye oval . . . . *A.* (*Nathrenus*) *jakli* Háva, 2001

5. First pair of legs with tibial spines . . . . *A.* (s. str.) *namibicus* Háva, 2000e
5a. First pair of legs without tibial spines . . . . 6.
6. Ventrites II-V covered with mix of yellowish (light brown) and white scales; 9th abdominal segment without distinct waist, with same width throughout its length, apex of segment with cordate, deep indentation; apex of paramers slightly curved in to middle, paramers with apex and median lobe slender and narrower, median lobe with distinct extension in 1/2 of its length . . . . *A.* (s. str.) *ardoi* sp. n.
6a. Ventrites I-V covered with white and light-brown scales; light-brown scales cover posterior margin of ventrites I-V and middle section of ventrite V; 9th abdominal sternite spatulate, with the apex narrow and flat, three times wider posteriorly than the apex width, distinct waist in a mid section present; parameres curved toward middle, setae present on apex and in inner margin of parameres, median lobe without distinct extension . . . . *A.* (s. str.) *flavipes flavipes* LeConte, 1854

DISCUSSION: Many of the species of the genus *Anthrenus* are similar externally. However, there are some species that have varying scales color and patterns (*A. flavipes flavipes* LeConte, 1854, *A. lepidus* LeConte, 1854, *A. pimpinellae pimpinellae* (F., 1775), *A. scrophulariae scrophulariae* (L., 1758) , *A. verbasci* (L., 1767); compare with Beal 1998, Hinton 1945, Kadej 2005a, b). Thus specimens of particular species can be often more similar to other distinct species than to typical form. As a result identification should be based on the general morphology of the male genitalia and details in structure of median lobe, shape of the 9th abdominal segment and respectively galea with lacinia in all cases.

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First record of the subfamily Pycnocheiridiinae from South America, with the description of *Leptocheiridium pfeiferae* gen. n., sp. n. (Arachnida:Pseudoscorpiones: Cheiridiidae)

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First record of the subfamily Pycnocheiridiinae from South America, with the description of *Leptocheiridium pfeiferae* gen. n., sp. n. (Arachnida: Pseudoscorpiones: Cheiridiidae). - The cheiridiid subfamily Pycnocheiridiinae is recorded for the first time from South America, *Leptocheiridium* gen. n. and its type species *pfeiferae* sp. n. are described and illustrated. The new genus shares with *Pycnocheiridium* Beier, 1964 (type genus of the Pycnocheiridiinae Beier, 1964) the same morphology of walking legs, eight trichobothria on the fixed chelal finger, only two on the movable finger, and the presence of strongly clavate vestitural setae. *Leptocheiridium* gen. n. is well characterized by the shape of its slender pedipalps, the presence of three sub-equal setae in the rallum, the presence of five setae on the cheliceral hand, the morphology of the female galea, and the presence of a well-developed transverse furrow on the carapace.

Keywords: Taxonomy - ecology - neotropical region - Ecuador - bark dweller.

INTRODUCTION

Beier (1964) erected, within the family Cheiridiidae, the subfamily Pycnochei - ridiinae Beier, 1964 for the monotypical genus *Pycnocheiridium* Beier, 1964 (with its type species *mirum* Beier, 1964). This genus.takes an intermediate position between Cheiridiidae Hansen, 1893 and Pseudochiridiidae Chamberlin, 1923 in having clearly separated femur and patella on walking legs I/II, femur+patella of legs III and IV with a distinct, nearly vertical suture (Judson, 1992), eight trichobothria on fixed chelal finger, and 5 setae on the cheliceral hand (pseudochiridiid characters), whilst having normal, unmodified coxae IV also in females, normal-shaped tergites (not chevron-shaped), a rallum with three setae, of which the anterior one is larger and dentate (Judson, 1992), and only two trichobothria on the movable chelal finger (cheiridiid characters). Only a few specimens of *Pycnocheiridium mirum* are recorded from South Africa (Eastern Cape, Kwazulu-Natal). Nothing is known on its biology (one female was "sifted, (from) very humid rain forest, very thick humus"), and it "appears to be one of the rarest South African species (of pseudoscorpions)" (Judson, 1992).

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Harvey (1992) placed Cheiridiidae (without mentioning the subfamily Pycnocheiridiinae), together with four other families, in the superfamily Garypoidea. Murienne *et al.* (2008) re-established the superfamily Cheiridioidea, including Cheiridiidae, Pseudochiridiidae and Sternophoridae, by using molecular sequence data. However, their analysis is based on a very low number of genera and species (three) studied. The phylogeny of Cheiridioidea and its validity as a superfamily has also been discussed by Judson (2000).

In the course of the worldwide research project (MACAG - Monitoring of Arthropods along Climate and Altitude Gradients: see Schmidl, 2009) conducted by the junior author (JS), 339 samples from tree bark were collected in 2007, 2008 and 2009 at 1000 m (warm rainforest), 2000 m (cloud forest) and 3000 m (Paramo transition forest) in the Podocarpus National Park in Ecuador, to analyze species compositions of arthropods in regard to patterns of diversity between trees, plots and altitudinal levels, and for the evaluation of the monitoring performance (application) of the corticolous arthropod fauna. Samples were taken using the barkspray method (protocol according to Schmidl, 2007). A defined area of a living, unbroken tree trunk bark is sprayed with a pyrethroid insecticide spray. Pyrethroids are contact poisons which are highly specific to arthropods and block voltage-sensitive sodium channels in the nerve membrane. Within a few minutes the arthropods lose the ability of coordinated movements and tumble down from the substratum. Pyrethroids show an immediate effect on all arthropods, but are relatively harmless for higher vertebrates. Before spraying, a plastic sheet is tightly pinned to the bottom of the sampled trunk to collect all affected arthropods, which after 15 minutes are brushed into a small, tree-wise labelled plastic bag (Whirl Paks) containing 70% ethanol.

Among the 287 pseudoscorpion specimens, representing seven families and 15 morphospecies, collected during this field survey, we found three specimens of a genus that we place with hesitation in the cheiridiid subfamily Pycnocheiridiinae. A new genus and species are described and figured below. It is well differentiated from *Pycnocheiridium*, the only other known genus in this subfamily.

DESCRIPTION

Leptocheiridium gen. n.

DIAGNOSIS: Member of Cheiridiidae, subfamily Pycnocheiridiinae. Tegument normally sclerotized, vestitural setae of carapace, tergites and pedipalps strongly broadened, leaf-like. Carapace subtriangular, with one pair of eyes, two distinct transverse furrows, the subbasal one flattened, metazone narrow. Most tergites divided, with unmodified lateral borders. Manducatory process rounded, with two marginal setae. Sternites IV to X divided, XI undivided; anal cone with 2 dorsal and 2 acute ventral setae and located between tergite XI and sternite XI; male genitalia of typical cheiridiid morphology (lateral sacs long, well developed, atrium of ejaculatory canal well developed, median genital sac short), female genitalia consisting of three major cribrate plates, the lateral ones more sclerotized than the larger median one. Pleural membrane striate, partly covered with granula. Chelicera with 5 setae on hand; galea short, distinct apical rami present only in female, subgaleal seta near galea base, rallum

with three setae, the distal one with a few fine denticles on anterior margin. Pedipalps coarsely granular, hand nearly parallel-sided; teeth on both fingers mostly acute and contiguous; fixed finger with 8 trichobothria (all situated in basal half of finger), movable finger with 2 trichobothria (*b* and *t*); long venom duct present in both fingers. Coxae IV much wider than coxae I. Leg I: femur distinctly longer than patella and with articulation, tarsal segments fused, without visible suture. Leg IV: femur much shorter than patella, suture nearly vertical, tarsal segments fused, without visible suture, no tactile tarsal seta; undivided arolia shorter than smooth claws.

TYPE SPECIES: *Leptocheiridium pfeiferae* sp. n.

ETYMOLOGY: The genus name is a combination of *Cheiridium* with the Greek adjective "leptos" (thin, slender), referring to the slender pedipalps.

AFFINITIES: *Leptocheiridium* gen. n. is distinguished from *Pycnocheiridium* by its slender pedipalps, the distinct transverse furrows on its carapace, the presence of 5 setae on its cheliceral hand, the female galea with 6 apical/subapical rami, and the three sub-equal setae of its rallum (in *Pycnocheiridium* the anterior seta is distinctly larger: Judson, 1992).

REMARKS: As currently defined, the subfamily Cheiridiinae of the Cheiridiidae, is characterized by having a reduced number of trichobothria on fixed (at most 7) and movable (at most 2) chelal fingers, by the fused femur and patella of leg I and the at least partly fused femur+patella of leg IV; coxa of leg IV also in females unmodified, not enlarged; carapace with two distinct transverse furrows, with depressed metazone (except in *Apocheiridium*), and two eyes; cheliceral hand with 4 setae; first seta of rallum enlarged.

The subfamily Pycnocheiridiinae differs from the Cheiridiinae by having femur and patella of leg I well separated and articulated, femur+patella of leg IV with distinct, nearly vertical suture, and eight trichobothria on the fixed chelal finger. Considering these differences, the Pycnocheiridiinae may even deserve familiar rank.

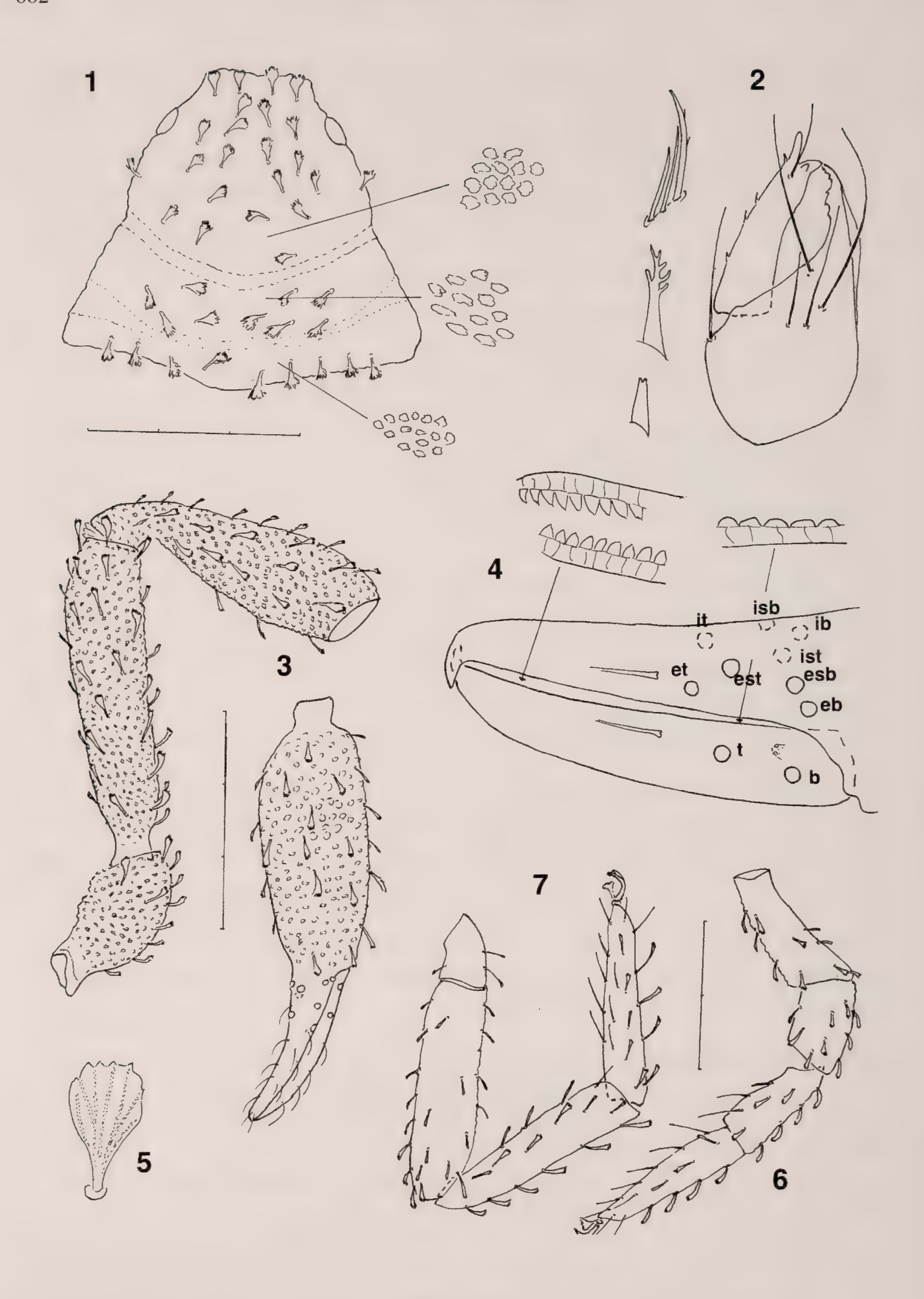
The new genus *Leptocheiridium* gen. n. confirms the main subfamiliar characters, but differs by the following: number of setae on cheliceral hand (4 vs 5) and morphology of rallum (3 setae, the first one not enlarged), which are probably of generic, but not of subfamiliar importance.

Leptocheiridium pfeiferae sp. n. Figs 1-10

HOLOTYPE: MHNG, without registration number; ♂; Ecuador, Prov. Zamora, env. Estación Científica San Francisco (ECSF), 2000m asl, cloud forest, on tree bark by bark spraying; 31.VIII.2009, lg. T. Pfeifer (tree # EL6B05).

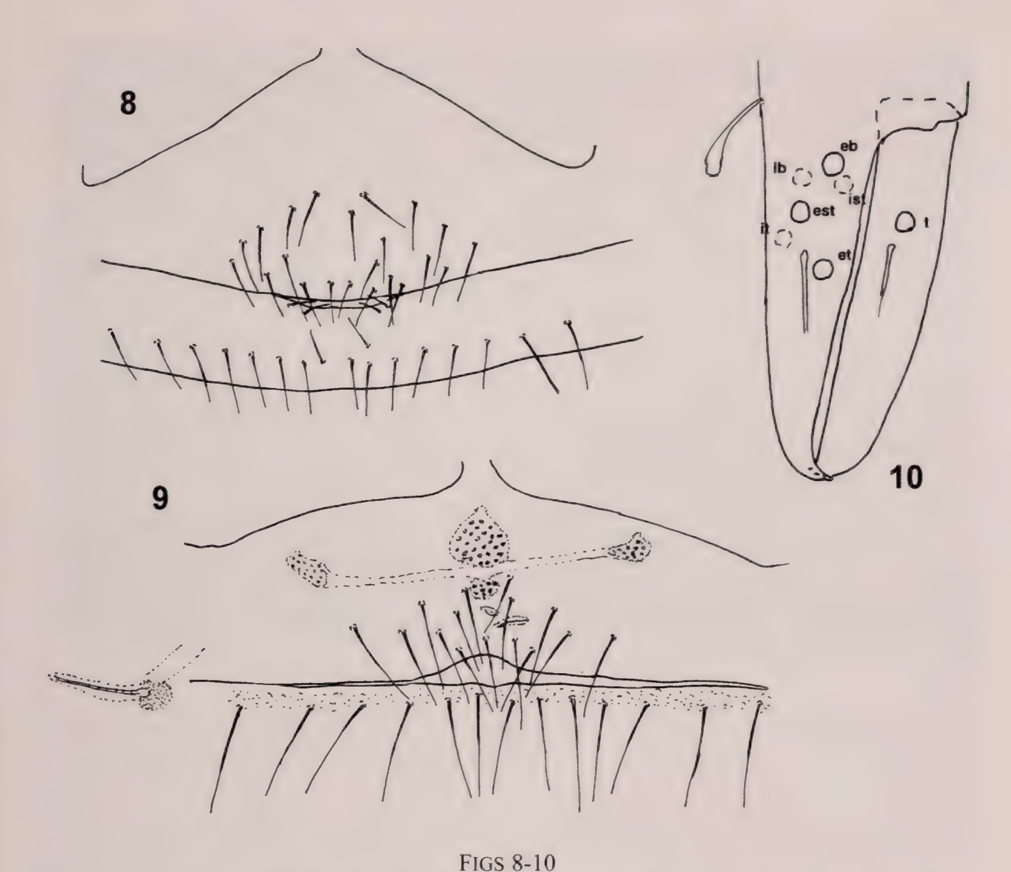
PARATYPES: MHNG, without registration number; 1 ♀ 1 deutonymph; same locality and method, 29.VIII.2009; lg. T. Pfeifer (tree # EQ5B07).

REMARK: The three specimens were collected on two different trees several hundred metres apart. Tree EL6B05 had a dimension at breast height (dbh = diameter at 130 cm height) of 26 cm, a medium coverage of climbing plants, a dense cover of epiphytes (mosses, lichens, algae), and a medium rough bark. Tree EQ5B07 had a dbh of 23 cm, differing from the previous tree by a very smooth bark. Both trees had an intact, unbroken bark.



FIGS 1-7

Leptocheiridium pfeiferae gen. n., sp. n., holotype. (1) Carapace, with granules enlarged. (2) Left chelicera ♂, with rallum and galea of ♂ and ♀ (paratype) enlarged. (3) Left pedipalp. (4) Tricho - bothrial pattern. (5) Tergal seta, enlarged. (6) Left leg I. (7) Right leg IV. Scale unit 0.1 mm.



FIGS 8-10

Leptocheiridium pfeiferae gen. n., sp. n. (8) Sternites II/III of male. (9) Sternites II/III of female, with cribrate plates. (10) Trichobothrial pattern of deutonymph.

DESCRIPTION OF ADULTS: Pedipalps, and carapace brown, tergites yellowish brown, legs including coxae reddish brown. Carapace (Fig. 1) subtriangular, broader than long (length/breadth = 0.9), with two transverse furrows, median furrow broad and laterally distad directed, granular, the subbasal one distinct only laterally; two distinct eyes with flat lenses; anterior margin straight, without epistome; coarsely granular; with 42-46 strongly clavate, leaf-like setae (4 along anterior, 7-9 along posterior margin). All tergites visible dorsally, I-X divided, coarsely granular, setae leaf-like (Fig. 5), chaetotaxy of half-tergites: 5-6/6/6/5-6/6/5-6/5-6/4-5/5/3-4, on IV-X one seta anterolaterally placed, tergite XI with 6 setae (no tactile setae). Manducatory process scaly, with 2 marginal setae; pedipalpal coxa coarsely granular, with 8-9 clavate setae, 0-2 smooth setae and one distal tactile seta, coxa I with 6-8 setae (2 slightly clavate), II with 8-13 smooth setae, III with 15-20, IV with 32-35 smooth setae; genital operculum of ♂ with 28 long setae (Fig. 8), 2/2 short entrance setae, genital organs similar to that of other cheiridiid species (e. g. Dumitresco & Orghidan, 1981; Judson, 1992); genital operculum of ♀ (Fig. 9) with 15 marginal and discal setae, medial cribrate plate apparently divided into one big and one small part, lateral cribrate plates small (Fig. 9);

sternites IV-X divided, the anterior ones scaly, the posterior ones ctenoid-scaly sculptured, some lyrifissures present in front of and between setae, XI undivided, ctenoid-scaly; setae on anterior sternites smooth, acute, on posterior ones slightly clavate (except lateral setae and those of XI), chaetotaxy of half-sternites: 6-8, 0 supra-stigmal setae/7-9+1 suprastigmal seta/8-9/7-8/6-7/5-7/5-6/4, lateral seta on V-X short. Anal cone situated between tergite and sternite XI, with 2 smooth dorsal and 2 (3 in holotype) ventral setae. Pleural membrane shortly granular-striate.

Chelicera (Fig. 2) with 5 long acute setae, *b* distinctly shorter than *sb*, *es* as long as sb; fixed finger with 3 retrorse teeth and 2-3 subapical granula, lamina exterior thin; movable finger of ♂ with a few thin, thorn-like projections on lateral side, one also at base of galea, with a tooth-like subapical lobe, subgaleal seta reaching clearly beyond tip of galea in ♂, reaching almost to tip of galea in ♀, galea of ♂ short (Fig. 2) and rounded, with 2 tiny rounded apical tubercles, galea of ♀ long, with 6 short sub-apical/apical rami; serrula exterior with 12 lamellae; rallum (Fig. 2) with 3 setae, anterior margin of distal one with 2-3 denticles.

Pedipalp (Fig. 3) coarsely granular, vestitural setae leaf-like, chelal finger with fine curved setae; trochanter with small dorsal hump, 2.0-2.1 times longer than broad; femur distally slightly broadened, with a distinct pedicel, 4.3 times longer than broad; patella 3.3 times longer than broad; hand parallel-sided, with pedicel 2.7 times (♂) or 2.3 times (♀) longer than broad and 1.6 times (♂) or 1.5 times (♀) longer than finger; chela with pedicel 4.4 times (♂) or 3.9 times (♀), without pedicel 4.2 times (♂) or 3.6 times (♀) longer than broad; teeth of chelal fingers acute, slightly retrorse (in distal third), then becoming flattened and rounded in basal part, fixed finger with 33 (♂) or 29 (♀) teeth, movable finger with 27 (♂) or 21 (♀) teeth; long venom duct present in both fingers, nodus ramosus situated in middle of finger; 10 trichobothria (Fig. 4), all 8 on fixed finger situated in basal half, 2 on movable finger situated in basal third (*b* and *t*, following Harvey, 1990); sensillum distal to *b*.

Leg I (Fig. 6): femur and patella articulated, femur 1.6 times (♂) or 1.4 times (♀) longer than patella, femur 2.4-2.5 times longer than deep, patella 1.6 times, tibia 2.3-2.6 times, tarsus 4.3-4.4 times longer than deep, tarsus 1.4-1.5 times longer than tibia; leg IV (Fig. 7): femur much shorter than patella, distinct suture nearly vertical, femur+patella 4.4-4.6 times longer than deep, tibia 4.9 (♂) or 4.5 (♀) times, tarsus 5.2 (♂) or 5.6 (♀) times longer than deep, no tactile setae present; undivided arolia shorter than smooth claws.

Measurements (in mm) ♂ (♀): Total length 1.4; carapace length/breadth 0.43/0.49 (0.44/0.51); pedipalp length/breadth: trochanter 0.23/0.11 (0.24/0.12), femur 0.44/0.10 (0.47/0.11), patella 0.40/0.12 (0.44/0.13), hand with pedicel 0.36/0.13 (0.37/0.12), length of pedicel 0.03, finger length 0.22 (0.24), chela length with pedicel 0.58 (0.62); leg I length/depth: femur 0.19/0.08 (0.19/0.08), patella 0.12/0.08 (0.14/0.08), tibia 0.16/0.05 (0.16/0.07), tarsus 0.22/0.05 (0.23/0.05); leg IV length/depth: femur+patella 0.40/0.09 (0.39/0.09), tibia 0.31/0.06 (0.32/0.07), tarsus 0.28/0.05 (0.31/0.06).

Description of deutonymph: Carapace 0.80 times broader than long, co - arsely granular, medial transverse furrow distinct, only lateral depressions of subbasal

FIGS 11-12

Photographs of tree EL6B05 (locality of holotype) (11) and of tree EQ5B07 (locality of paratypes) (12).

furrow distinct, metazone unsclerotized; 2 flattened eyes; 25 leaf-like setae, 4 along anterior and 6 along posterior margin; tergites divided, smooth, half-tergites with 3 leaf-like marginal setae, tergite XI with 4 setae; manducatory process with 2 setae, pedipalpal coxa with 5 leaf-like setae, coxa I/II with 3, III with 5, IV with 7 smooth acute setae, half-sternites mostly with 3 acute setae, sternite XI with 4 setae. Chelicera with 5 setae on hand, galea with 4 apical/subapical rami, serrula exterior with 10(?) lamellae. Pedipalp: femur 3.5 times longer than broad (0.26 mm/0.07 mm); patella 2.9 times longer than broad (0.24/0.08); hand with pedicel 2.2 times (0.23/0.11) longer than broad and 1.36 times longer than hand with pedicel, finger length 0.17 mm; chela with pedicel 3.8 times, without pedicel 3.6 times longer than broad; fixed finger with 23, movable finger with 21 teeth. Six trichobothria on fixed finger (3 anti- and 3 paraxial ones), movable finger with one trichobthrium (Fig. 10).

ETYMOLOGY: This species is dedicated to Miss Tina Pfeifer (Fürth) for collecting and processing the pseudoscorpions in the 2009 sampling campaign. She invested much time for taxonomic pre-sorting and photographic documentation of this collection in the course of her "Zulassungsarbeit" at the University of Erlangen-Nuremberg.

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Four new species from China and Southeast Asia (Diptera, Lauxaniidae, Homoneurinae)

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Four new species from China and Southeast Asia (Diptera, Lauxaniidae, Homoneurinae). - Four new species are described and illustrated, including *Cestrotus quadrimaculatus* sp. n., *Dioides merzi* sp. n., *Noonamyia bipunctata* sp. n. and *Noonamyia flavoscutellata* sp. n., and seven species are recorded for the first time from Vietnam, Thailand, Philippines and/or Malaysia, including *Cestrotus flavoscutellatus* Meijere, 1910, *Cestrotus liui* Shi, Yang & Gaimari, 2009, *Cestrotus heteropterus* Shi, Yang & Gaimari, 2009, *Dioides furcatus* Shi & Yang, 2009, *Dioides incurvatus* Shi & Yang, 2009, *Noonamyia sabahna* Sasakawa & Pong, 1990, *Noonamyia sasakawai* Papp, in Papp, Merz & Földvári, 2006 and *Phobeticomyia uncinata* Shi & Yang, 2009. The species *Noonamyia sasakawai* is redescribed and illustrated completely according to two paratypes and several additional specimens. A key to all species of the genus *Noonamyia* of the world is presented.

Keywords: Lauxaniidae - Homoneurinae - new species - key - Southeast Asia.

INTRODUCTION

The family Lauxaniidae is one of the larger Acalyptratae families. There are more than 160 genera and nearly 2000 described species, distributed worldwide except for Antarctica. The following four genera, which belong to the subfamily Homoneurinae, *Cestrotus* Loew, 1862, *Dioides* Kertész, 1915, *Noonamyia* Stuckenberg, 1971 and *Phobeticomyia* Kertész, 1915 have conspicuous wing patterns. The genus *Cestrotus* includes 11 described species in the Oriental Region and 13 in the Afrotropical Region; the genus *Dioides* includes 6 described species in the Oriental Region and 1 in the Australasian/Oceanian Region; the genera *Noonamyia* and *Phobeticomyia* are represented by 12 and 6 described species respectively, distributed exclusively in the Oriental Region (Shi, Yang & Gaimari, 2009; Shi, Li & Yang, 2009a, 2009b; Shi & Yang, 2009).

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In the present paper, four new species are described and illustrated, namely *Cestrotus quadrimaculatus* sp. n., *Dioides merzi* sp. n., *Noonamyia bipunctata* sp. n. and *Noonamyia flavoscutellata* sp. n., and seven species are recorded for the first time from Vietnam, Thailand, Philippines and/or Malaysia: *Cestrotus liui* Shi, Yang & Gaimari, 2009, *Cestrotus heteropterus* Shi, Yang & Gaimari, 2009, *Dioides furcatus* Shi, Li & Yang, 2009, *Dioides incurvatus* Shi, Li & Yang, 2009, *Noonamyia sabahna* Sasakawa & Pong, 1990, *Noonamyia sasakawai* Papp, in Papp, Merz & Földvári, 2006 and *Phobeticomyia uncinata* Shi, Li & Yang, 2009. The species *Noonamyia sasakawai* is redescribed and illustrated completely based on two paratypes and additional specimens, and a key to separate all species of the genus *Noonamyia* is presented.

MATERIAL AND METHODS

The specimens examined are deposited in the following collections:

BMNH The Natural History Museum, London, UK
BPBM Bernice P. Bishop Museum, Honolulu, Hawai'i, USA
CASC California Academy of Sciences, San Francisco, California, USA
CAUC Entomological Museum of China Agricultural University, Beijing, China
CNCI Canadian National Collection of Insects, Ottawa, Ontario, Canada
CSCA California State Collection of Arthropods, Sacramento, California, USA
HNHM Hungarian Natural History Museum, Budapest, Hungary
MHNG Musèum d'histoire naturelle, Genève, Switzerland
MZSP Museu de Zoología, Universidade de São Paulo, São Paulo, Brazil
NHMW Naturhistorisches Museum Wien, Vienna, Austria
NMSA KwaZulu-Natal Museum, Pietermaritzburg, South Africa
QSBG Queen Sirikit Botanic Garden, Chiangmai, Thailand
USNM National Museum of Natural History, Washington, DC, USA
ZISP Zoological Institute, Russian Academy of Sciences, St Petersburg, Russia

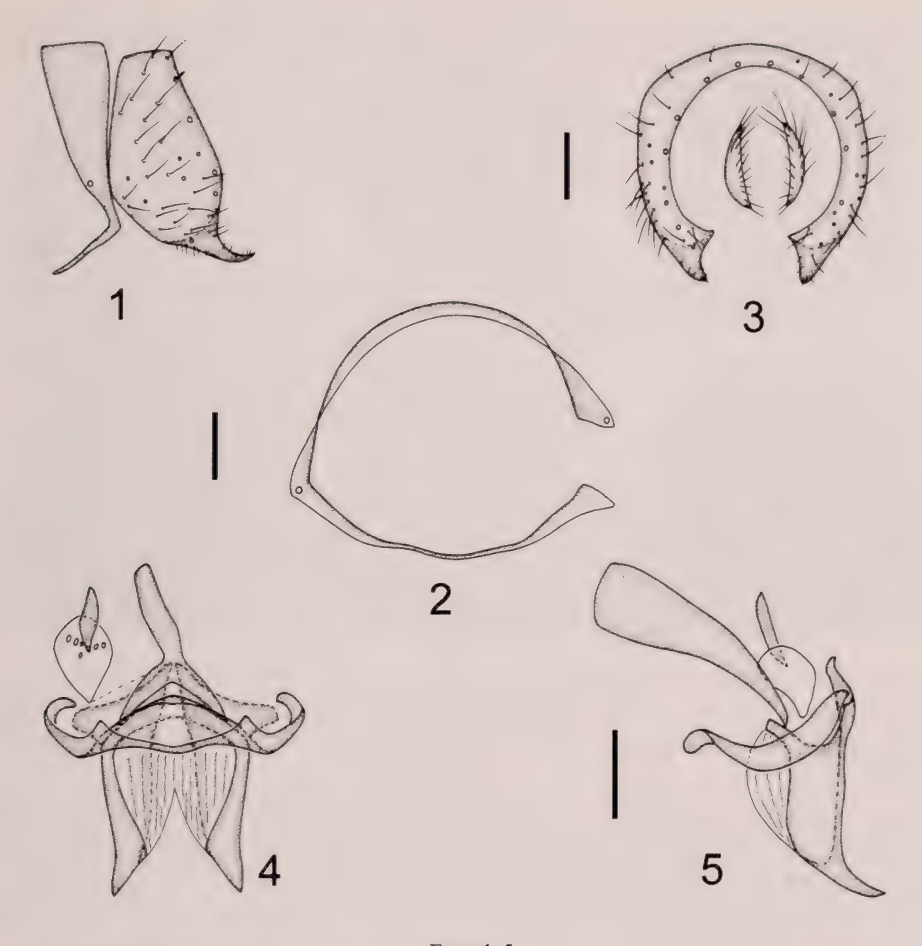
Terminology follows McAlpine (1981) and Shewell (1987). Genitalia preparations were made by removing and macerating the apical portion of the abdomen in cold saturated NaOH for 2-6 hours. After examination, genitalia were transferred to fresh glycerin and stored in a microvial pinned below the specimen.

The following abbreviations are used: *a* - anterior seta, *acr* - acrostichal seta, *ad* - anterior dorsal seta, *anepst* - anepisternal seta, *app* - apical posterior seta, *apv* - apical ventral seta, *av* - anterior ventral seta, *dc* - dorsocentral seta, *kepst* - katepisternal seta, *oc* - ocellar seta, *or* - fronto-orbital seta, *pd* - posterior dorsal seta, *prsc* - prescutellar seta, *pv* - posterior ventral seta, *sa* - supra-alar seta.

SYSTEMATIC PART

Cestrotus quadrimaculatus sp. n. Figs 1-5, Plates A1, A3, B1

MATERIAL: HOLOTYPE ♂ (MHNG): Thailand, Kamphaeng Phet Province, KhlongLan District, nr KhlongLan Watf., 280 m, 16.07.51N/99.16.41E, 11-12.XII.2003, P. Schwendinger. PARATYPES: **THAILAND**. – **Chaiyaphum Province**, Pa Hin Ngam NP, deciduous, 15°39.966'N 101°27.198'E, 357 m, 19-23.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1352) (1♂, QSBG). – Pa Hin Ngam NP, deciduous, 15°40.232'N 101°26.942'E, 398 m, 5-12.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai



FIGS 1-5

Cestrotus quadrimaculatus sp. n., male paratype. (1) Epandrium and protandrium, lateral view. (2) Protandrium, anterior view. (3) Epandrium, posterior view. (4) Aedeagal complex, ventral view. (5) Aedeagal complex, lateral view. Scale 0.1 mm.

(T1345) (2♂♂, 2♀♀, CSCA). – Pa Hin Ngam NP, Dry dipterocarp, 15°38.099'N 101°23.921'E, 698 m, 11-18.viii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T445) (1♂, BPBM). – Pa Hin Ngam NP, Dry evergreen forest at waterfall, 15°34.802'N 101°25.99'E, 430 m, 22-28.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1038) (1♂, 1♀, CSCA). – Pa Hin Ngam NP, Dry evergreen forest at waterfall, 15°34.802'N 101°25.99'E, 430 m, 16-22.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1035) (1♂, 3♀♀, CSCA). – Pa Hin Ngam NP, Dry evergreen next to creek, 15°40.569'N 101°26.705'E, 461 m, 19-23.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1353) (3♂♂, 1♀, QSBG). – Pa Hin Ngam NP, ecotone between mix deciduous and dipterocarp forest, 15°38.132'N 101°23.922'E, 698 m, 7-13.ii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1646) (1♂, QSBG). – Pa Hin Ngam NP, Ecotone between mixed deciduous and dry dipterocarp forest, 15°34.913'N 101°25.658'E, 444 m, 16-22.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1034) (1♂, 1♀, CNCI). – Pa Hin Ngam NP, Ecotone between mixed deciduous and dry dipterocarp forest, 15°34.913'N 101°25.658'E, 444 m, 10-16.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1031) (1♀, USNM).

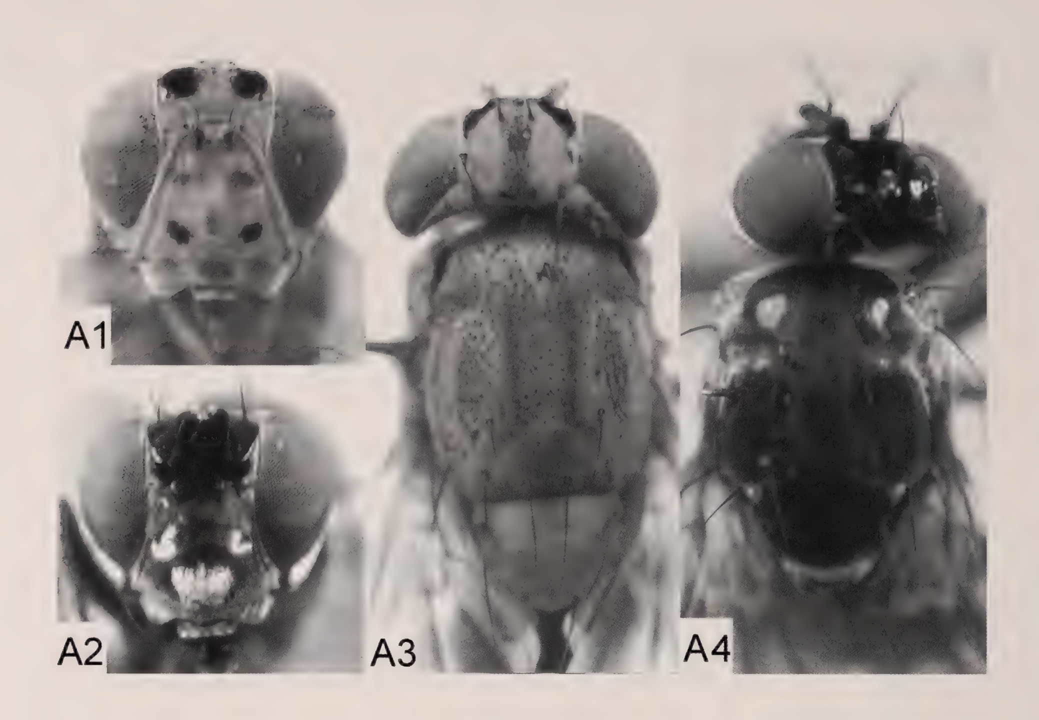


PLATE A

Head, anterior view and thorax, dorsal view. (1), (3) *Cestrotus quadrimaculatus* sp. n. (2), (4) *Dioides merzi* sp. n.

– Pa Hin Ngam NP, Mixed deciduous forest, 15°34.686'N 101°26.082'E, 419 m, 22-28.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1039) (1♂, CSCA). – Pa Hin Ngam NP, Nature trail at Lan Hin Nor, 15°37.615'N 101°23.436'E, 668 m, 15-21.iii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T2331) (1♀, USNM). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1457) (1♂, 1♀, BMNH). – Tat Tone NP, By the stream, 15°58.771'N 102°2.397'E, 305 m, 19-26.i.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1564) (1♂, QSBG). – Tat Tone NP, Chaiyapoom forest fire station, 16°0.738'N 102°1.342'E, 195 m, 26.xii.2006-2.i.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1377) (1♂, USNM). – Tat Tone NP, Dry Dipterocarp Forest, 15°59.037'N 102°2.103'E, 250 m, 25-27.vi.2006, ex. Malaise trap, coll: M. Sharkey (T10) (1♀, BPBM). – Tat Tone NP, Lum pa tao head water/dry evergreen, 15°58.486'N 102°2.239'E, 270 m, 19-26.ii.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1733) (1♂, QSBG). – Tat Tone NP, Phu hang sing, 15°58.723'N 102°2.231'E, 290 m, 26.i.-2.ii.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1569) (1♂, QSBG). – Tat Tone NP, Streamside at Tat Fah waterfall, 15°56.463'N 102°5.953'E, 242 m, 26.iii.-2.iv.2007, ex. Malaise trap, coll: Tawit Jaruphan&Orawan Budsawong (T2355) (2♂♂, 1♀, BPBM). – Tat Tone NP, Streamside at Tat Fah waterfall, 15°56.463'N 102°5.953'E, 242 m, 5-12.iii.2007, ex. Malaise trap, coll: Tawit Jaruphan&Orawan Budsawong (T2346) (2♀♀, QSBG). – **Chiang Mai Province**, Doi Inthanon NP, Vachirathan Fall, 18°32.31'N 98°36.048'E, 700 m, 15-22.iv.2007, ex. Malaise trap, coll: Y. Areeluck (T1842) (1♀, CSCA).– **Kamphaeng Phet Province**, data same as holotype (1♂, CAUC). – **Khonkaen Province**, Nam Pong NP, office, 16°37.341'N 102°34.467'E, 324 m, 19-26.vii.2006, ex. Malaise trap, coll: Khamphol Jaidee (T109) (1♂, QSBG). – Nam Pong NP, office, 16°37.377'N 102°34.454'E, 344 m, 19-26.vii.2006, ex. Malaise trap, coll: Khamphol Jaidee (T111) (1♂, QSBG). – **Loei Province**, Phu Kradueng NP, Forest protection unit Loei .5

(Phakbung), 16°50.54'N 101°41.663'E, 406 m, 25.ii.-1.iii.2007, ex. Malaise trap, coll: Sonkgran Kamtue (T1505) (2♂♂, CSCA; 2♀♀, QSBG). – Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.54'N 101°41.663'E, 406 m, 7-13.ii.2007, ex. Malaise trap, coll: Sutin Khonglasae (T1496) (1♂, 1♀, QSBG; 2♀♀, CSCA). – **Phetchabun Province**, Khao Kho NP, Mix deciduous, 16°39.589'N 101°8.185'E, 168 m, 5-12.i.2007, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T1392) (1♂, USNM). – Khao Kho NP, Mix deciduous, 16°39.589'N 101°8.185'E, 168 m, 19-26.i.2007, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T1398) (1♂, QSBG). – Khao Kho NP, Mix deciduous near office, 16°39.587'N 101°8.134'E, 220 m, 26.ii.2007, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T1608) (1♀, CNCI). – Khao Kho NP, office, 16°39.479'N 101°8.105'E, 220 m, 12-19.vii.2006, ex. Malaise trap, coll: Somchai Chatchumnan & Sa-ink Singtong (T166) (1♂, USNM). – Khao Kho NP, View point at Khla Stream, 16°39.12'N 101°7.81'E, 246 m, 12-19.iii.2007, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T2413) (3♀♀, QSBG; 1♀, BPBM). – Sakon Nakhon Province, Phu Phan NP, Nam Hom Waterfall # Sao Hi, 17°7.34'N 104°0.788'E, 344 m, 25-31.iii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T2377) (1♂, 1♀, USNM). – Phu Phan NP, North of well, 17°3.543'N 103°58.452'E, 312 m, 23-30.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1525) (2♂♂, 1♀, USNM). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 5-11.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1517) (2♂♂, 1♀, CNCI). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 17-23.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1523) (1♂, 1♀, NHMW). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 23-30.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1526) (1♀, QSBG). – **Ubon Ratchathani Province**, Pha Taem NP, Saeng Chan Waterfall, 15°31.985'N 105°35.774'E, 155 m, 12-20.iii.2007, ex. Malaise trap, coll: Porntip Tonsu & Bunlu Sapsiri (T2146) (1♀, QSBG). **VIETNAM**. – **Tay Ninth Province**, Nui Ba Den, 300 m, 11.22N/106.11E, 20-21.VIII.2003, P. Schwendinger (1♀, MHNG; 1♂, CAUC).

ETYMOLOGY: Latin, *quadri-*, prefix meaning four + *maculatus*, meaning maculate or with spots, referring to the face having a pair of pale brown subbasal spots and a pair of blackish brown round subapical spots; a masculine adjective.

DIAGNOSIS: Face with a pair of pale brown subbasal spots and a pair of blackish brown round subapical spots. Antennal 1st flagellomere entirely yellow. Palpus yellow. Mesonotum with a pair of grayish brown median stripes, a pair of grayish brown sublateral stripes along upper margin of *sa* and a pair of brownish gray lateral stripes behind suture. Scutellum yellow with dense yellow pruinosity. All legs yellow, femora with a grayish black apicoventral spot, tibiae with a subbasal and apical black ring and tarsomeres 3-5 brown. Wing with a wide, brown, subapical stripe from costal margin to hind margin; a hyaline elliptical spot on M_1 present between *r-m* and *dm-cu*; *r-m* and *dm-cu* brown. Abdomen brown to black with dense gray pruinosity, some tergites with yellow laterally.

DESCRIPTION

Length: body 3.5-4.0 mm (male), 4.0 mm (female); wing 3.4-3.7 mm (male), 3.7 mm (female).

Head (Plates A1, A3) pale yellow. Frons as long as wide and parallel-sided, with dense pale yellow pruinosity; with a pair of black velvety triangular spots, covering base of anterior *or* and a median hump slightly projecting anteriorly; ocellar triangle grayish black, with 3 rows of short setulae on grayish median stripe behind ocellar triangle; *oc* strong and longer than anterior *or*; anterior *or* reclinate, shorter than posterior *or*. Face covered by sparse white pruinosity, with a pair of pale brown subbasal spots, a pair of blackish brown subapical spots and three dark spots on ventral

margin. Gena about 1/4 height of eye, with 1 long seta and a black spot. Antennal scape and pedicel grayish black, 1st flagellomere entirely yellow, nearly 1.8 times as long as high; arista brown, long plumose, with longest setula as long as height of 1st flagellomere. A pale brown spot present between antenna and eye. Proboscis yellow, except pale brown at tip, with yellowish and blackish setulae; palpus yellow, with blackish setulae.

Thorax (Plate A3) black, with dense grayish and yellowish pruinosity. Mesonotum with a pair of grayish brown median stripes, a pair of grayish brown sublateral stripes along upper margin of *sa*, a pair of brownish gray lateral stripes behind suture and a black rectangular spot on postpronotum; 0+2 *dc*; *acr* in irregular 8 rows; *prsc* longer than 1st postsutural *dc*. 1 *anepst*, 2 *kepst*. Scutellum yellow, with dense yellow pruinosity. Halter pale yellow.

Legs yellow, all femora with sparse grayish pruinosity and a grayish black apicoventral spot, all tibiae with a subbasal and apical black ring and tarsomeres 3-5 brown. Fore femur with 4-5 *pv* and 5-6 *pd*, ctenidium with 12 short setulae; fore tibia with 1 preapical *ad* and 1 short *apv*. Mid femur with 5 *a*; mid tibia with 1 preapical *ad* and 2 strong *apv*. hind tibia with 1 short preapical *ad* and 1 short *apv*.

Wing (Plate B1) hyaline, with brown irregular spots; a wide brown subapical stripe extending from costal margin to hind margin; an hyaline elliptical spot on M_1 present between *r-m* and *dm-cu*; *r-m* and *dm-cu* brown; subcostal cell hyaline, with a pale brown round apical spot, extending nearly to R_{2+3}; Costa with 2nd (between R_1 and R_{2+3}), 3rd (between R_{2+3} and R_{4+5}) and 4th (between R_{4+5} and M_1) sections in proportion of 1.7 mm : 0.6 mm : 0.3 mm; *r-m* beyond middle of distal cell; ultimate and penultimate sections of M_1 in proportion of 1.1 mm: 2.0 mm; ultimate section of CuA_1 about 1/13 of penultimate.

Abdomen brown to black, with dense gray pruinosity, some tergites with yellow laterally. Male genitalia (Figs 1-5): protandrium circular; epandrium broad in lateral view; surstylus with an acuate process, curved upward; hypandrium broad at middle and curved backward, hypandrial apodeme small; aedeagus with a pair of triangular basal processes, a deep apical incision, subuliform apically in ventral view and curved backward in lateral view.

REMARKS: The new species is similar to *Cestrotus pilosus* (Hendel) from Tanzania. According to the original description by Hendel (1920) and study of the type, they share the following characters: face with white pruinosity and brown spots, antennal scape and pedicel grayish black, 1st flagellomere yellow, mesonotum with *acr* in 8 rows, wing broadly brown in apical third. But it can be separated from the latter by the pruinose brown stripe behind the ocellar triangle flanked on both sides by solid yellow pruinose upper frons, the mesonotum having a pair of grayish brown median stripes and a pair of short brownish gray lateral stripes separated completely, the scutellum having grayish yellow pruinosity, and the distal margin of the wing being hyaline. In *Cestrotus pilosus*, the area behind the ocellar triangle is concolorous with the upper frons, the mesonotum has four brown stripes confluent on the anterior half and isolated on the posterior half, the scutellum is bright yellow pruinose, the distal margin of the wing is completely brown with no marginal hyaline area, and other details of the wing differ.

DISTRIBUTION: Thailand, Vietnam.

Cestrotus flavoscutellatus Meijere, 1910

Cestrotus flavoscutellatus Meijere, 1910: 142. Type locality: Indonesia (Java).

MATERIAL: **THAILAND**. – **Loei Province**, Phu Ruea NP, Nern Wibaak ditch, 17°29.907'N 101°20.483'E, 1196 m, 19-26.ii.2007, ex. Malaise trap, coll: Patikhom Tumtip (T1711) (1♂, QSBG).

DISTRIBUTION: China (Guangxi, Hainan, Hunan, Taiwan), Laos, Nepal, Indonesia (Java), Malaysia (Sabah), Vietnam, new record to Thailand.

Cestrotus liui Shi, Yang & Gaimari, 2009

Cestrotus liui Shi, Yang & Gaimari, 2009: 57. Type locality: China (Yunnan).

MATERIAL: **MALAYSIA**. – **Pahang**, Bukit Fraser, Maxwell Trail, 1300 m, 3.43N/ 101.44E, 12-16.V.2004, P. Schwendinger (2♂♂, 1♀, MHNG; 1♂, CAUC). **THAILAND**. – **Loei Province**, Phu Kradueng NP, Savannah in pine forest, 16°53.092'N 101°47.413'E, 1257 m, 9-16.i.2007, ex. Malaise trap, coll: Thanongsak Srisa-ad (T1226) (1♂, QSBG).

DISTRIBUTION: China (Hainan, Yunnan), new records to Malaysia and Thailand.

Cestrotus heteropterus Shi, Yang & Gaimari, 2009

Cestrotus heteropterus Shi, Yang & Gaimari, 2009: 54. Type locality: China (Yunnan).

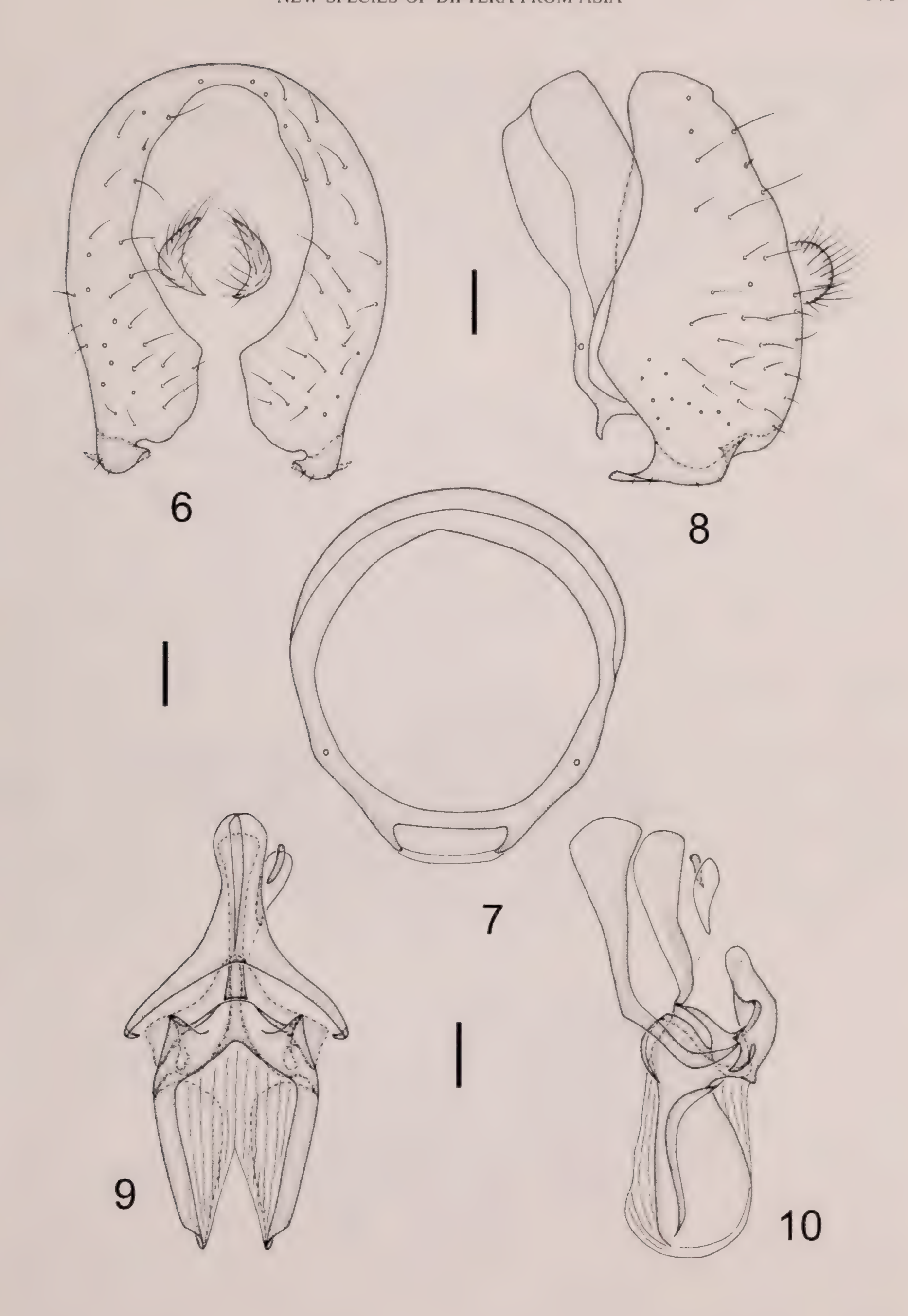
MATERIAL: **MALAYSIA**. – **Kelantan**, Gua Keris, Gua King Kong, South Pahang, 130 m, 52.1N/102.01E, 8-9.VI.2004, P. Schwendinger (1♂, MHNG). **THAILAND**. – **Chaiyaphum Province**, Pa Hin Ngam NP, Car park at Thung Dok Kra Jeow, 15°38.391'N 101°23.609'E, 750 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1456) (3♂♂, 1♀, USNM). – Pa Hin Ngam NP, Car park at Thung Dok Kra Jeow, 15°38.391'N 101°23.609'E, 750 m, 19-25.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1462) (1♀, QSBG). – Pa Hin Ngam NP, deciduous, 15°39.966'N 101°27.198'E, 357 m, 11-12.xii.2006, ex. pan trap, coll: Katae Sa-nog & Buakaw Adnafai (T1344) (1♀, CNCI). – Pa Hin Ngam NP, Dry evergreen next to creek, 15°40.569'N 101°26.705'E, 461 m, 19-23.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1353) (1♀, CSCA). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 19-25.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1464) (3♂♂, 2♀♀, QSBG; 1♀, BPBM). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1458) (3♂♂, QSBG). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 3-4.i.2007, ex. pan trap, coll: Katae Sa-nog & Buakaw Adnafai (T1448) (1♂, CSCA). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 4-5.i.2007, ex. pan trap, coll: Katae Sa-nog & Buakaw Adnafai (T1449) (1♂, 1♀, USNM). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 19-25.i.2007, ex. Malaise trap, coll: Katae Sanog & Buakaw Adnafai (T1463) (1♂, QSBG). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 2-3.i.2007, ex. pan trap, coll: Katae Sa-nog & Buakaw Adnafai (T1447) (1♂, 3♀♀, CSCA). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 5-6.i.2007, ex. pan trap, coll: Katae Sa-nog & Buakaw Adnafai (T1450) (1♀, QSBG). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1457) (2♂♂, 3♀♀, QSBG). – Tat Tone NP, Dry Dipterocarp Forest, 15°59.037'N 102°2.103'E, 250 m, 25-27.vi.2006, ex. Malaise trap, coll: M. Sharkey (T10) (1♂, QSBG). – Tat Tone NP, Dry dipterocarp forest near swamp at Sab somboon forest unit, 16°1.059'N 101°58.603'E, 674 m, 26.xi.-3.xii.2006, ex. Malaise trap, coll: Tawit Jaruphan (T1146) (1♀, USNM). – Tat Tone NP, Lum pa tao head water/dry evergreen, 15°58.486'N 102°2.239'E, 270 m, 19-26.ii.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1733) (2♀♀, USNM). – Tat Tone NP, Next to Pa Eang waterfall, 15°57.657'N 101°54.724'E, 301 m,

19-26.x.2006, ex. Malaise trap, coll: Tawit Jaruphan (T685) (1♂, QSBG). – Tat Tone NP, Streamside at Tat Fah waterfall, 15°56.463'N 102°5.953'E, 242 m, 5-12.iii.2007, ex. Malaise trap, coll: Tawit Jaruphan&Orawan Budsawong (T2346) (1♂, USNM). – **Chiang Rai Province**, Doi Inthanon NP, summit marsh, 18°35.361'N 98°29.157'E, 2500 m, 12-19.x.2006, ex. Malaise trap, coll: Y. Areeluck (T368) (1♂, QSBG). – Mae Si District, Doi Tung, 1300 m, 20.19.28N/99.49.53E, 17.XII.2003, P. Schwendinger (3♂♂, MHNG). – **Chumphon Province**, Lang Suan District, Khao Kai Jae. waterf., 80 m, 9.55N/98.57E, 17-18.VII.2002, P. Schwendinger (6♂♂, 2♀♀, MHNG). – Loei Province, Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.493'N 101°41.726'E, 412 m, 7-13.ii.2007, ex. Malaise trap, coll: Sutin Khonglasae (T1497) (4♂♂, 4♀♀, QSBG; 2♂♂, 1♀, CSCA; 2♂♂, 1♀, USNM; 2♂♂, 1♀, BMNH; 2♂♂, 1♀, BPBM; 2♂♂, 1♀, CNCI; 2♂♂, 1♀, MHNG; 2♂♂, 1♀, MZSP; 2♂♂, 1♀, NHMW; 2♂♂, 1♀, NMSA). – Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.54'N 101°41.663'E, 406 m, 13-19.ii.2007, ex. Malaise trap, coll: Wuthicahi kwanjam (T1499) (4♂♂, 4♀♀, CSCA). – Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.54'N 101°41.663'E, 406 m, 13-19.ii.2007, ex. Malaise trap, coll: Wuthicahi kwanjam (T1499) (3♂♂, 2♀♀, QSBG; 2♂♂, CSCA; 1♀, BMNH; 1♀, MHNG; 1♀, MZSP; 1♀, NHMW; 1♀, NMSA). – Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.54'N 101°41.663'E, 406 m, 7-13.ii.2007, ex. Malaise trap, coll: Sutin Khonglasae (T1496) (3♂♂, 1♀, USNM; 5♂♂, CSCA; 1♀, BPBM; 1♀, CNCI). – Phu Kradueng NP, Hill evergren forest at Wang Gwang forest unit, 16°53.362'N 101°47.286'E, 1262 m, 3-9.i.2007, ex. Malaise trap, coll: Thanongsak Srisa-ad (T1222) (1♂, CSCA). – Phu Kradueng NP, Savannah in pine forest, 16°53.092'N 101°47.413'E, 1257 m, 9-16.i.2007, ex. Malaise trap, coll: Thanongsak Srisa-ad (T1226) (2♂♂, CNCI). – Phu Ruea NP, Nature tail, 17°30.74'N 101°20.65'E, 1353 m, 5-12.iii.2007, ex. Malaise trap, coll: Patikhom Tumtip (T2305) (1♀, QSBG). – **Phetchabun Province**, Khao Kho NP, Mixed deciduous forest, 16°32.539'N 101°2.483'E, 524 m, 11-12.xii.2006, ex. pan trap, coll: Somchai Chachumnan & Saink Singtong (T1177) (1♀, QSBG). – Phitsanulok Province, Thung Salaeng Luang NP, Dry Evergreen forest, 16°50.277'N 100°52.917'E, 486 m, 18-25.iii.2007, ex. Malaise trap, coll: Pongpitak & Pranee & Sathit (T2388) (1♀, BPBM). – Sakon Nakhon Province, Phu Phan NP, Behind forest protection unit at Huay Wien Prai, 17°6.81'N 104°0.318'E, 318 m, 25.ii.-3.iii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1693) (1♂, 1♀, CSCA). – Phu Phan NP, Behind forest protection unit at Huay Wien Prai, 17°6.847'N 104°0.302'E, 376 m, 4-10.ii.2007, ex. Malaise trap, coll: Winlon Kongnara (T1685) (1♂, BPBM). – Phu Phan NP, Dry evergreen forest near house at 1567 station, 16°48.628'N 103°53.591'E, 522 m, 22-29.xii.2006, ex. Malaise trap, coll: S. Kongnara (T1250) (1♀, QSBG). – Phu Phan NP, Nam Hom Waterfall # Sao Hi, 17°7.34'N 104°0.788'E, 344 m, 10-17.iii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T2371) (1♀, CNCI). – Phu Phan NP, North of well, 17°3.543'N 103°58.452'E, 312 m, 5-11.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1516) (1♀, QSBG). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 11-17.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1520) (1♂, BPBM). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 5-11.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1517) (2♂♂, 3♀♀, USNM). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 23-30.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1526) (1♀, QSBG). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 17-23.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1523) (2♂♂, 1♀, QSBG).– **Sunat Thanai Province**, Khao Sok National Park, 100 m, 8.54.55N/98.31.39E, 12-14.V.2003, P. Schwendinger (1♂, MHNG). – **Trat Province**, Ko Chang, 12.03N/102.18E, 17-18.VII.2002, P. Schwendinger (1♀, MHNG). **VIETNAM**. – **Dong Nai Province**, NW Tan Phu, 130 m, 11.25N/107.26E, 26-29.VIII.2003, P. Schwendinger (1♀, MHNG). – **Lam Dong Province**, W Di Linh, Bo Bia Wat. Fall, 860 m, 11.34N/ 108.01E, 03.IX.2003, P. Schwendinger (1♀, CAUC). – **Tay Ninh Province**, Tay Ninh, Nui Ba Den, 300 m, 11.22N/106.11E, 20-21.VIII.2003, P. Schwendinger (8♂♂, 3♀♀, MHNG; 1♂, CAUC).

DISTRIBUTION: China (Yunnan), Thailand, new records to Malaysia and Vietnam.

Dioides merzi sp. n. Figs 6-10, Plates A2, A4, B2

MATERIAL: HOLOTYPE ♂ (MHNG): Vietnam, Tay Ninh Province, Tay Ninh, Nui Ba Den, 300 m, 11.22N/106.11E, 20–21.VIII.2003, P. Schwendinger. PARATYPES: **THAILAND**. –



FIGS 6-10

Dioides merzi sp. n., male paratype. (6) Epandrium and protandrium, lateral view. (7) Protandrium, anterior view. (8) Epandrium, posterior view. (9) Aedeagal complex, ventral view. (10) Aedeagal complex, lateral view. Scale 0.1 mm.

Chaiyaphum Province, Pa Hin Ngam NP, Car park at Thung Dok Kra Jeow, 15°38.391'N 101°23.609'E, 750 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1456) (1♂, 1♀, USNM). – Pa Hin Ngam NP, deciduous, 15°39.966'N 101°27.198'E, 357 m, 19-23.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1352) (5♂♂, 5♀♀, CSCA; 2♂♂, 2♀♀, BMNH; 5♀♀, USNM). – Pa Hin Ngam NP, deciduous, 15°40.232'N 101°26.942'E, 398 m, 5-12.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1345) (1♀, USNM). – Pa Hin Ngam NP, Dry dipterocarp, 15°38.099'N 101°23.921'E, 698 m, 11-18.viii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T445) (1♀, USNM). – Pa Hin Ngam NP, Dry evergreen forest (Thepana watrfall), 15°38.884'N 101°25.84'E, 605 m, 1-7.x.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T658) (1♂, QSBG). – Pa Hin Ngam NP, Dry evergreen forest at Lan Hin Nor, 15°37.54'N 101°23.313'E, 673 m, 21-27.iii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T2335) (1♀, QSBG). – Pa Hin Ngam NP, Dry evergreen forest at Lan Hin Nor, 15°37.54'N 101°23.313'E, 673 m, 9-15.iii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T2329) (3♂♂, 3♀♀, QSBG). – Pa Hin Ngam NP, Dry evergreen forest at Lan Hin Nor, 15°37.54'N 101°23.313'E, 673 m, 15-21.iii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T2332) (2♂♂, 2♀♀, QSBG; 1♂, 2♀♀, MHNG; 2♀♀, CNCI). – Pa Hin Ngam NP, Dry evergreen forest at waterfall, 15°34.802'N 101°25.99'E, 430 m, 16-22.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1035) (6♂♂, 3♀♀, CSCA). – Pa Hin Ngam NP, Dry evergreen forest at waterfall, 15°34.802'N 101°25.99'E, 430 m, 22-28.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1038) (2♂♂, 2♀♀, CSCA). – Pa Hin Ngam NP, Dry evergreen forest at waterfall, 15°34.802'N 101°25.99'E, 430 m, 10-16.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1032) (1♀, CSCA). – Pa Hin Ngam NP, Dry evergreen next to creek, 15°40.569'N 101°26.705'E, 461 m, 19-23.xii.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1353) (2♂♂, 3♀♀, QSBG; 2♂♂, 3♀♀, CSCA). – Pa Hin Ngam NP, Ecotone between mixed deciduous and dry dipterocarp forest, 15°34.913'N 101°25.658'E, 444 m, 10-16.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1031) (1♂, 2♀♀, CSCA). – Pa Hin Ngam NP, Ecotone between mixed deciduous and dry dipterocarp forest, 15°34.913'N 101°25.658'E, 444 m, 16-22.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1034) (6♂♂, 8♀♀, CSCA; 2♂♂, 2♀♀, QSBG). – Pa Hin Ngam NP, Mixed deciduous forest, 15°34.686'N 101°26.082'E, 419 m, 22-28.xi.2006, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1039) (1♂, 2♀♀, CSCA). – Pa Hin Ngam NP, Nature trail at Lan Hin Nor, 15°37.615'N 101°23.436'E, 668 m, 15-21.iii.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T2331) (2♂♂, 4♀♀, QSBG; 1♂, 6♀♀, CSCA; 1♂, 6♀♀, USNM). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1458) (3♂♂, 1♀, CSCA). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 13-19.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1461) (1♂, 1♀, USNM). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 1-7.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1455) (1♂, NMSA). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dipterocarpus forest, 15°38.208'N 101°23.556'E, 720 m, 19-25.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1464) (2♂♂, 3♀♀, QSBG; 2♂♂, 2♀♀, NMSA; 2♂♂, 1♀, CASC). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 19-25.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1463) (1♂, QSBG). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1457) (2♂♂, 3♀♀, MZSP; 2♂♂, 2♀♀, ZISP). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 13-19.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1460) (3♂♂, 3♀♀, QSBG). – Pa Hin Ngam NP, Thung Dok Kra Jeow in Dry evergreen, 15°38.438'N 101°23.576'E, 780 m, 7-13.i.2007, ex. Malaise trap, coll: Katae Sa-nog & Buakaw Adnafai (T1457) (5♂♂, 4♀♀, BPBM; 3♀♀, QSBG; 3♀♀, USNM). – Tat Tone NP, By the creek at Takfah waterfall, 15°56.463'N 102°5.953'E, 242 m, 26.ix.-3.x.2006, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T875) (1♀, MZSP). – Tat Tone NP, By the stream, 15°58.538'N 102°2.153'E, 280 m, 12-19.i.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1562) (1♂, QSBG). – Tat Tone NP, By the stream, 15°58.771'N 102°2.397'E, 305 m, 12-19.i.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong

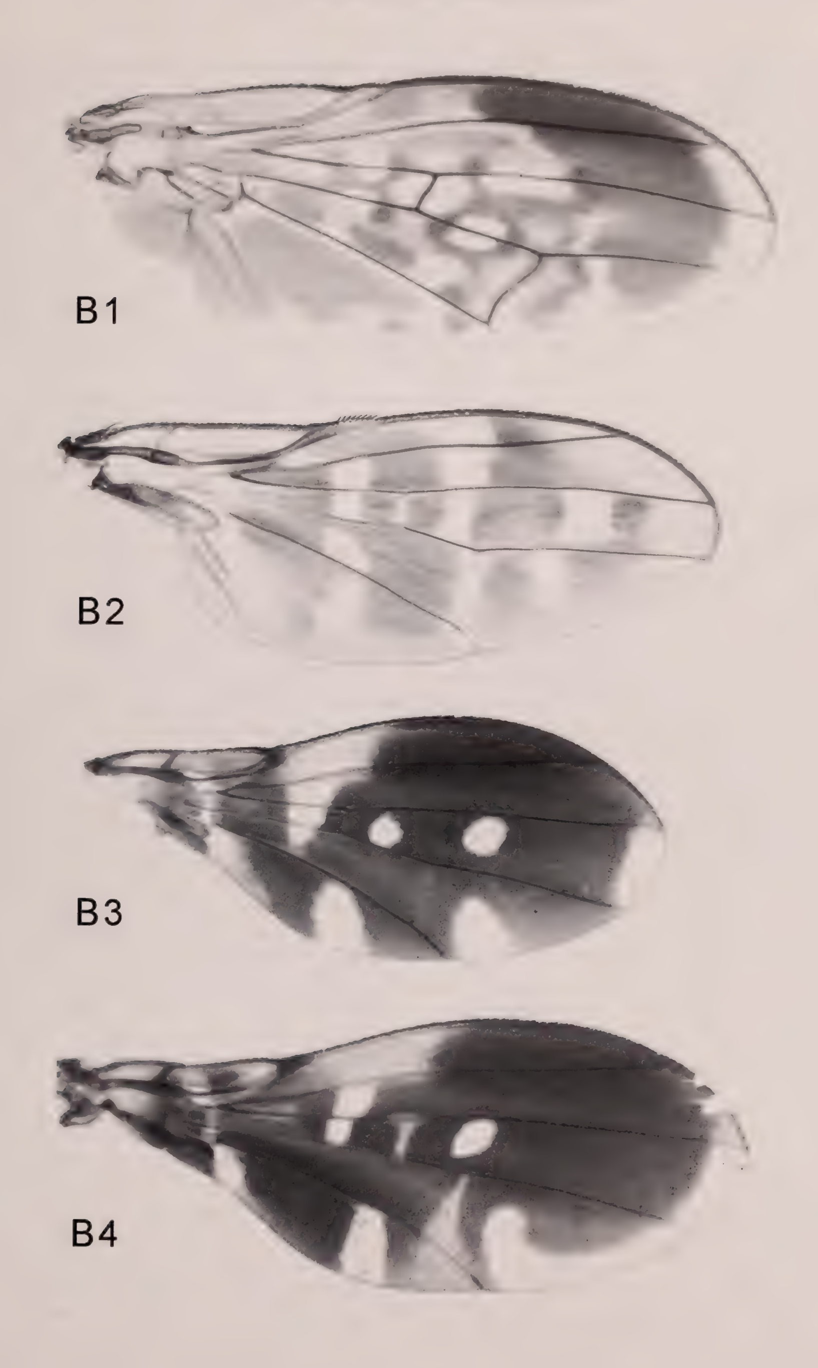


PLATE B

Wing. (1) *Cestrotus quadrimaculatus* sp. n. (2) *Dioides merzi* sp. n. (3) *Noonamyia bipunctata* sp. n. (4) *Noonamyia flavoscutellata* sp. n.

(T1561) (1♀, ZISP). – Tat Tone NP, Chaiyapoom forest fire station, 16°0.738'N 102°1.342'E, 195 m, 19-23.xii.2006, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1374) (1♂, USNM). – Tat Tone NP, Chaiyapoom forest fire station, 16°0.738'N 102°1.342'E, 195 m, 26.xii.2006-2.i.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1377) (1♂, QSBG). – Tat Tone NP, Dry Dipterocarp Forest, 15°59.037'N 102°2.103'E, 250 m, 21-28.vi.2006, ex. Malaise trap, coll: Vinlon Khongnara (T19) (1♀, BPBM). – Tat Tone NP, Dry Dipterocarp Forest, 15°59.037'N 102°2.103'E, 250 m, 28.vi.2006, ex. Malaise trap, coll: Pong Sandow (T18) (1♀, ZISP). – Tat Tone NP, Dry Dipterocarp Forest, 15°59.037'N 102°2.103'E, 250 m, 25-27.vi.2006, ex. Malaise trap, coll: M. Sharkey (T10) (1♀, CASC). – Tat Tone NP, Dry dipterocarp forest near swamp at Sab somboon forest unit, 16°1.059'N 101°58.603'E, 674 m, 26.xi.-3.xii.2006, ex. Malaise trap, coll: Tawit Jaruphan (T1146) (1♀, QSBG). – Tat Tone NP, Dry dipterocarp forest near swamp at Sab somboon forest unit, 16°1.059'N 101°58.603'E, 674 m, 12-19.xi.2006, ex. Malaise trap, coll: Tawit Jaruphan (T1140) (1♀, QSBG). – Tat Tone NP, Nursery near head water, 15°58.344'N 102°2.169'E, 257 m, 5-12.viii.2006, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T547) (1♀, QSBG). – Tat Tone NP, Phu hang sing , 15°58.723'N 102°2.231'E, 290 m, 26.i.2.ii.2007, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T1569) (1♀, CASC). – Tat Tone NP, Staff house at Takfah waterfall, 15°56.461'N 102°5.955'E, 242 m, 19-26.ix.2006, ex. Malaise trap, coll: Tawit Jaruphan & Orawan Budsawong (T873) (1♀, BPBM). – **Chiang Mai Province**, Doi Inthanon NP, summit marsh, 18°35.361'N 98°29.157'E, 2500 m, 12-19.x.2006, ex. Malaise trap, coll: Y. Areeluck (T368) (1♀, QSBG). – **Loei Province**, Phu Kradueng NP, Forest protection unit Loei .5 (Phakbung), 16°50.54'N 101°41.663'E, 406 m, 7-13.ii.2007, ex. Malaise trap, coll: Sutin Khonglasae (T1496) (1♂, QSBG). – Phu Kradueng NP, Koke Hin Ngam, 16°51.817'N 101°50.704'E, 270 m, 9-16.viii.2006, ex. Malaise trap, coll: Sutin Khonglasae (T483) (1♂, QSBG). – Phu Kradueng NP, Mixed deciduous forest north of Na Noy Forest Unit, 16°48.17'N 101°47.666'E, 276 m, 2-8.xii.2006, ex. Malaise trap, coll: Suthin Gong-lasae (T1084) (1♀, BPBM). – Phu Kradueng NP, Mixed deciduous forest south of Na Noy Forest Unit, 16°49.099'N 101°47.624'E, 275 m, 14-20.xi.2006, ex. Malaise trap, coll: Suthin Gong-lasae (T1074) (2♂♂, 2♀♀, CSCA; 1♂, 1♀, USNM). – Phu Kradueng NP, Mixed deciduous forest south of Na Noy Forest Unit, 16°49.099'N 101°47.624'E, 275 m, 18-19.xi.2006, ex. pan trap, coll: Suthin Gong-lasae (T1070) (1♀, QSBG). – Phu Kradueng NP, Mixed deciduous forest south of Na Noy Forest Unit, 16°49.099'N 101°47.624'E, 275 m, 20-26.xi.2006, ex. Malaise trap, coll: Daorueng Sinhpreecha (T1077) (1♂, CSCA). – Phu Kradueng NP, Road to Ta Krong waterfall of Na Noy Forest Unit, 16°48.913'N 101°47.634'E, 265 m, 14-20.xi.2006, ex. Malaise trap, coll: Suthin Gong-lasae (T1073) (3♂♂, USNM). – Phu Ruea NP, Nern Pitsawong, 17°29.676'N 101°21.093'E, 1168 m, 5-12.xi.2006, ex. Malaise trap, coll: Patikhom Tumtip (T1117) (1♂, BPBM). – Phu Ruea NP, Nern Wibaak ditch, 17°29.907'N 101°20.483'E, 1196 m, 26.viii.-2.ix.2006, ex. Malaise trap, coll: Nukoonchai Jaroenchai (T533) (1♂, CNCI). – Phu Ruea NP, Nern Wibaak ditch, 17°29.907'N 101°20.483'E, 1196 m, 19-26.ii.2007, ex. Malaise trap, coll: Patikhom Tumtip (T1711) (1♂, QSBG). – Phu Ruea NP, Reservior, 17°28.826'N 101°21.33'E, 931 m, 5-12.i.2007, ex. Malaise trap, coll: Patikhom Tumtip (T1538) (1♂, NHMW). – **Phetchabun Province**, Khao Kho NP, Mix deciduous, 16°39.572'N 101°8.194'E, 171 m, 12-19.i.2007, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T1394) (1♂, 3♀♀, CSCA). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.539'N 101°2.483'E, 242 m, 26.xi.-2.xii.2006, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singhtong (T978) (1♂, MHNG). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.539'N 101°2.483'E, 242 m, 10-11.xi.2006, ex. pan trap, coll: Somchai Chachumnan & Saink Singhtong (T966) (1♀, NHMW). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.539'N 101°2.483'E, 242 m, 12-19.xi.2006, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singhtong (T972) (1♀, USNM). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.539'N 101°2.483'E, 242 m, 9-10.xi.2006, ex. pan trap, coll: Somchai Chachumnan & Saink Singhtong (T965) (1♂, 1♀, CASC). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.539'N 101°2.483'E, 242 m, 19-26.xi.2006, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singhtong (T975) (1♂, QSBG). – Khao Kho NP, Mixed deci - duous forest at Ta Phol river, 16°32.561'N 101°2.479'E, 242 m, 12-19.xi.2006, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singhtong (T971) (1♂, 1♀, CSCA). – Khao Kho NP, Mixed deciduous forest at Ta Phol river, 16°32.561'N 101°2.479'E, 242 m, 5-12.xi.2006, ex.

Malaise trap, coll: Somchai Chachumnan & Saink Singhtong (T968) (2♂♂, USNM). – Khao Kho NP, Nursery, 16°52.573'N 101°8.077'E, 520 m, 26.x.-2.xi.2006, ex. Malaise trap, coll: Somchai Chatchumnan and Sa-ink Singtong (T812) (1♂, USNM). – Khao Kho NP, Nursery, 16°52.581'N 101°8.06'E, 520 m, 12-19.x.2006, ex. Malaise trap, coll: Somchai Chatchumnan and Sa-ink Singtong (T808) (1♂, QSBG). – Khao Kho NP, Savana at nursery, 16°52.568'N 101°8.104'E, 520 m, 6-7.x.2006, ex. pan trap, coll: Somchai Chatchumnan and Sa-ink Singtong (T797) (3♀♀, USNM). – Khao Kho NP, Thanthip waterfall, 16°39.087'N 101°7.777'E, 210 m, 5-12.ix.2006, ex. Malaise trap, coll: Somchai Chachumnan & Saink Singtong (T589) (1♀, BMNH). – Nam Nao NP, Tham Pra Laad Forest Unit, 16°44.963'N 101°27.833'E, 711 m, 4-5.vii.2006, ex. pan trap, coll: Noopean Hongyothi (T417) (1♂, CSCA). – Nam Nao NP, Tham Pra Laad Forest Unit, 16°44.986'N 101°27.874'E, 711 m, 31.vii.-7.viii.2006, ex. Malaise trap, coll: Noopean Hongyothi (T422) (1♀, USNM). – Nam Nao NP, Tham Pra Laad Forest Unit, 16°44.999'N 101°27.804'E, 715 m, 21-28.viii.2006, ex. Malaise trap, coll: Leng Janteab (T429) (1♂, QSBG). – **Phitsanulok Province**, Thung Salaeng Luang NP, Moist evergreen, 16°50.641'N 100°52.894'E, 557 m, 25.viii.-1.ix.2006, ex. Malaise trap, coll: Pongpitak Pranee (T572) (1♂, CSCA). – **Sakon Nakhon Province**, Phu Pha Yon NP, Channel, 16°55.639'N 104°10.748'E, 295 m, 17-23.vii.2006, ex. Malaise trap, coll: Manop Ngoyjansri & Chatree Cheaukamjan (T295) (1♀, CSCA). – Phu Pha Yon NP, Reservoir, 16°55.655'N 104°10.658'E, 280 m, 23-29.vii.2006, ex. Malaise trap, coll: Manop Ngoyjansri & Chatree Cheaukamjan (T299) (1♀, QSBG). – Phu Phan NP, Behind forest protection unit at Huay Wien Prai, 17°6.81'N 104°0.318'E, 318 m, 25.ii.-3.iii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1693) (1♂, 3♀♀, QSBG). – Phu Phan NP, Behind forest protection unit at Huay Wien Prai, 17°6.847'N 104°0.302'E, 376 m, 17-25.ii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1691) (1♂, 1♀♀, CSCA; 2♀♀, QSBG). – Phu Phan NP, Behind forest protection unit at Huay Wien Prai, 17°6.863'N 104°0.327'E, 387 m, 10-17.ii.2007, ex. Malaise trap, coll: Winlon Kongnara (T1689) (1♀, BPBM). – Phu Phan NP, Behind Huay Wien Prai Forest Unit, 17°6.863'N 104°0.327'E, 387 m, 8-15.viii.2006, ex. Malaise trap, coll: Vinlon Khongnara (T508) (1♂, QSBG). – Phu Phan NP, Behind Huay Wien Prai Forest Unit, 17°6.863'N 104°0.327'E, 387 m, 2-8.viii.2006, ex. Malaise trap, coll: Vinlon Khongnara (T505) (1♀, CNCI). – Phu Phan NP, Behind Huay Wien Prai Forest Unit, 17°6.863'N 104°0.327'E, 387 m, 2-8.viii.2006, ex. Malaise trap, coll: Vinlon Khongnara (T505) (1♂, QSBG). – Phu Phan NP, car park at Kam hom waterfall, 17°7.411'N 104°1.016'E, 347 m, 10-16.ix.2006, ex. Malaise trap, coll: Sailom Tongboonchai (T611) (1♀, QSBG). – Phu Phan NP, Creek at northend of Huay Nam Pung Forest Unit, 16°55.789'N 103°54.158'E, 305 m, 6-13.xi.2006, ex. Malaise trap, coll: Sailom Tongboonchai (T1096) (1♀, MHNG). – Phu Phan NP, Kam Hom waterfall at Haew Sin chai, 17°7.415'N 104°1.179'E, 347 m, 10-16.ix.2006, ex. Malaise trap, coll: Sailom Tongboonchai (T613) (1♀, QSBG). – Phu Phan NP, Nam Hom Waterfall # Sao Hi, 17°7.34'N 104°0.788'E, 344 m, 25-31.iii.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T2377) (1♀, QSBG). – Phu Phan NP, North of well, 17°3.543'N 103°58.452'E, 312 m, 11-17.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1519) (3♂♂, 3♀♀, CNCI; 1♂, 5♀*, QSBG; 3♂♂, MHNG). – Phu Phan NP, North of well, 17°3.543'N 103°58.452'E, 312 m, 23-30.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1525) (2♂♂, 5♀♀, USNM; 2♂♂, 2♀♀, QSBG; 2♂♂, 2♀♀, CSCA). – Phu Phan NP, North of well, 17°3.543'N 103°58.452'E, 312 m, 5-11.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1516) (14♂♂, 6♀♀, USNM; 3♂♂, 3♀♀, CSCA; 3♂♂, 2♀♀, QSBG). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 23-30.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1526) (3♂♂, 11♀♀, QSBG; 2♂♂, 4♀♀, MHNG; 2♂♂, 2♀♀, NHMW; 1♂, MZSP; 1♂, ZISP). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 17-23.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1523) (8♂♂, 15♀♀, USNM; 3♂♂, 3♀♀, CSCA; 3♂♂, 3♀♀, QSBG). – Phu Phan NP, West of well, 17°3.521'N 103°58.45'E, 322 m, 5-11.i.2007, ex. Malaise trap, coll: Sailom Tongboonchai (T1517) (4♂♂, 2♀♀, QSBG; 4♂♂, 2♀♀, BPBM; 4♂♂, 2♀♀, CSCA; 4♂♂, 2♀♀, CNCI; 4♂♂, 2♀♀, USNM; 2♂♂, 2♀♀, BMNH; 2♂♂, 2♀♀, MHNG; 2♂♂, 2♀♀, NHMW; 2♂♂, 2♀♀, NMSA; 2♂♂, 1♀, CASC; 2♂♂, 1♀, MZSP; 2♂♂, 1♀, ZISP). – **Ubon Ratchathani Province**, Pha Taem NP, East of Thung Luang in Dipterocarpus forest, 15°39.989'N 105°30.468'E, 238 m, 14-21.i.2007, ex. Malaise trap, coll: Thongkam & Pakdee (T1481) (1♂, BMNH). – Pha Taem NP, Don Huay Can, 15°40.016'N 105°30.502'E, 246 m, 11-18.xii.2006, ex. Malaise trap, coll: Thongcome & Pakdee (T1202) (2♂♂, 2♀♀, QSBG). – Pha Taem NP, Don Huay Can, 15°40.016'N 105°30.502'E, 246 m,

25.xii.2006-1.i.2007, ex. Malaise trap, coll: Thongcome & Pakdee (T1208) (1♀, QSBG). – Pha Taem NP, Don Huay Sa-nhom, 15°27.435'N 105°34.838'E, 238 m, 23.v.-30.v.2007, ex. Malaise trap, coll: Sorawit Mingman (T2193) (1♀, QSBG). – Pha Taem NP, First tier of Huay Sa Nhom waterfall, 15°27.407'N 105°34.867'E, 230 m, 4-11.xi.2006, ex. Malaise trap, coll: Sorawit and Thongdee (T1053) (1♂, QSBG). – Pha Taem NP, First tier of Huay Sa Nhom waterfall, 15°27.407'N 105°34.867'E, 230 m, 25.xi.-2.xii.2006, ex. Malaise trap, coll: Sorawit and Thongdee (T1062) (1♂, CSCA). – Pha Taem NP, Foot of Phu Kra jeaw, 15°39.989'N 105°30.468'E, 238 m, 4-11.xii.2006, ex. Malaise trap, coll: Thongcome & Pakdee (T1200) (3♂♂, 1♀, QSBG). – Pha Taem NP, Huay Pok waterfall, 15°37.321'N 105°36.982'E, 419 m, 27.x.-3.xi.2006, ex. Malaise trap, coll: Pornthip Tonsu (T730) (1♀, NMSA). – Pha Taem NP, Huay Pok waterfall, 15°37.321'N 105°36.982'E, 419 m, 4-11.iv.2007, ex. Malaise trap, coll: Bunlu Sapsiri (T2165) (1♂, CNCI). – Pha Taem NP, Huay Pok waterfall, 15°37.321'N 105°36.982'E, 419 m, 13-20.x.2006, ex. Malaise trap, coll: Pornthip Tonsu (T724) (1♀, QSBG). – Pha Taem NP, Irrigation area west of Huay Pok forest unit, 15°37.321'N 105°36.982'E, 419 m, 6-13.x.2006, ex. Malaise trap, coll: unknown (T719) (1♂, 2♀♀, QSBG). – Pha Taem NP, Kua nang nee, 15°24.258'N 105°30.855'E, 193 m, 18-25.viii.2006, ex. Malaise trap, coll: Bunlu Subsiri (T469) (1♂, QSBG). – Pha Taem NP, Kua nang nee, 15°24.258'N 105°30.855'E, 193 m, 5-12.viii.2006, ex. Malaise trap, coll: Bunlu Subsiri (T463) (1♂, 1♀, CNCI; 1♂, 1♀, MHNG). – Pha Taem NP, Pah mhon, 15°24.304'N 105°31.258'E, 230 m, 5-12.viii.2006, ex. Malaise trap, coll: Bunlu Subsiri (T461) (3♀♀, QSBG). – Pha Taem NP, Pah mhon, 15°24.304'N 105°31.258'E, 230 m, 5-12.viii.2006, ex. Malaise trap, coll: Bunlu Subsiri (T461) (1♂, QSBG). – Pha Taem NP, Phu Samui foothill, 15°40.021'N 105°30.448'E, 240 m, 2-9.vi.2007, ex. Malaise trap, coll: Tongcam & Banlu (T2207) (1♂, 1♀, QSBG). – Pha Taem NP, Rong Hi Noy, 15°40.021'N 105°30.448'E, 240 m, 1-7.i.2007, ex. Malaise trap, coll: Thongkam & Pakdee (T1476) (1♀, QSBG). – Pha Taem NP, west of HuayPok substation, 15°37.212'N 105°36.903'E, 438 m, 18-25.iv.2007, ex. Malaise trap, coll: Bunlu Sapsiri (T2170) (1♀, CNCI). – Pha Taem NP, Wild flower field 1, 15°27.336'N 105°34.87'E, 232 m, 4-11.xi.2006, ex. Malaise trap, coll: Sorawit and Thongdee (T1054) (1♂, USNM). **VIETNAM**. – **Lam Dong Province**, 7 km W Di Linh, 860 m, 11.34N/108.01E, 03.IX.2003, P. Schwendinger (1♂, CAUC). – **Tay Ninh Province**, data same as holotype (6♂♂, 2♀♀, MHNG; 1♂, 3♀♀, CAUC).

Etymology: The new species is named after the Entomologist Bernhard Merz who is our good friend and gives us so many kind and generous helps.

Diagnosis: Frons velvety black except fronto-orbital plate shining black. Face with dense grayish white pruinosity, a black velvety basal spot between antennae, and a silvery white trapeziform pruinose spot on spherical median convexity. Antennal 1st flagellomere yellow except dorsal margin and tip brown black. A silvery white pruinose spot present between base of antenna and eye. Palpus black. Mesonotum covered by dense yellow pruinosity except two lateral margins and sutures with grayish white pruinosity, and a pair of grayish median stripes extending to posterior margin and confluent with a large black velvety spot. Wing with three white spots present between R_1 and M_1, a white spot respectively in cells dm and cua_1, a white luniform spot beyond *dm-cu* and a white stripe on *dm-cu*; subcostal cell brown. Abdominal tergites 3-6 with dense grayish pruinosity along lateral margins.

Description

Length: Body 3.7-4.3 mm (male), 3.7-4.2 mm (female); wing 3.3-3.8 mm.

Head (Plates A2, A4) black. Frons velvety black except fronto-orbital plate shining black, wider than long and parallel-sided; a silvery white triangular pruinose spot close to inner and outer vertical setae; ocellar triangle black; *oc* strong and longer than posterior *or*; anterior *or* reclinate, shorter than posterior *or*. Face with dense grayish white pruinosity, a black velvety basal spot between antennae, a silvery white

trapeziform pruinose spot on spherical median convexity; parafacial with dense silvery white pruinosity. Gena with dense silvery white pruinosity and 1 long seta. Antennal scape and pedicel black; 1st flagellomere coniform, yellow except dorsal margin and tip brown black, 1.7 times as long as high; arista brown, long plumose, with longest setula longer than height of 1st flagellomere. A silvery white pruinose spot present between base of antenna and eye. Proboscis blackish brown, with yellowish and blackish setulae; palpus black, with blackish setulae.

Thorax (Plate A4) brownish black. Mesonotum with dense yellow pruinosity, except two lateral margins and sutures with grayish white pruinosity, and with a pair of grayish median stripes extending to posterior margin and confluent with a large black velvety spot, a pair of grayish spots on each side of a large black velvety semicircular spot; 0+3 *dc*, anterior *dc* hair-like, slightly longer than *acr* in lateral view, and close to second *dc*; *acr* in 6 rows; *prsc* weak hair–like. Anepisternum and katepisternum with dense grayish white pruinosity; 1 *anepst*, 1 *kepst*. Scutellum brown with a large black velvety spot on basal 2/3 and a grayish white spot on each side of large black spot; distal margin silvery pruinose to black, sometimes with ground color of margin yellowish. Halter yellow.

Legs: femora blackish brown with sparse grayish white pruinosity; tibiae yellow, silvery shining on dorsal side, with an apical black ring; and all tarsomeres yellow except 3-5 pale brown. Fore femur with 3 *pv* and 6 *pd*; fore tibia with 1 preapical *ad* and 1 short *apv*. Mid femur with 5 *a*; mid tibia with 1 preapical *ad* and 2 strong *apv*. Hind femur with 2 *ad*, hind tibia with 1 short preapical *ad* and 1 short *apv*.

Wing (Plate B2) grayish with irregular whitish spots; three white spots present between R_1 and M_1, a white spot respectively in cells dm and cua_1, a white luniform spot beyond *dm-cu* and a white stripe on *dm-cu*; subcostal cell brown; Costa with 2nd (between R_1 and R_{2+3}), 3rd (between R_{2+3} and R_{4+5}) and 4th (between R_{4+5} and M_1) sections in proportion of 1.4 mm: 0.7 mm: 0.3 mm; *r-m* beyond middle of cell dm; ultimate and penultimate sections of M_1 in proportion of 1.2 mm: 1.3 mm; ultimate section of CuA_1 about 1/6 of penultimate.

Abdomen blackish brown, tergites 3-6 each with dense grayish pruinosity along lateral margins. Male genitalia (Figs 6-10): protandrium circular with two small ventral processes; epandrium broad; surstylus with a claviform anterior ventral process and a incision on inner side in posterior view; hypandrium Y-shaped; gonopod degenerate; aedeagus with a pair of triangular basal processes, constricted apically with a deep incision in ventral view but round and broad apically in lateral view.

REMARKS: The new species is unique in the genus by the following characters: frons velvety black except fronto-orbital plate shining black, face dense grayish white pruinose, a black velvety basal spot present between antennae and a silvery white trapeziform pruinose spot on the spherical median convexity, and a different wing pattern.

DISTRIBUTION: Thailand, Vietnam.

Dioides furcatus Shi, Li & Yang, 2009

Dioides furcatus Shi, Li & Yang, 2009: 95. Type locality: China (Hainan) (CAUC).

MATERIAL: **THAILAND**. – **Nakhon Si Thammarat Province**, Khao Luang National Park, 380 m, 8.22.45N/99.44.22E, 17. VII. 2005, P. Schwendinger (1 ♀, MHNG). – **Phetchabun**

Province, Khao Kho NP, Nursery, 16°52.573'N 101°8.077'E, 520 m, 19-26.x.2006, ex. Malaise trap, coll: Somchai Chatchumnan and Sa-ink Singtong (T809) (1♂, QSBG). **VIETNAM**. – **Lam Dong Province**, 7 km W Di Linh, 860 m, 11.34N/108.01E, 3. IX. 2003, P. Schwendinger (2♂♂, MHNG).

DISTRIBUTION: China (Hainan), new records to Thailand and Vietnam.

Dioides incurvatus Shi, Li & Yang, 2009

Dioides incurvatus Shi, Li & Yang, 2009: 96. Type locality: China (Yunnan) (CAUC).

MATERIAL: **THAILAND**. – **Chiang Mao Province**, Chiang Dao District outside Süa Dao cave, 450 m, 19.23.33N/98.55.55E, 27.XII.2007, P. Schwendinger (1♀, MHNG).

DISTRIBUTION: China (Yunnan), new record to Thailand.

Phobeticomyia uncinata Shi, Li & Yang, 2009

Phobeticomyia uncinata Shi, Li & Yang, 2009: 62. Type locality: China (Yunnan) (CAUC).

MATERIAL: **THAILAND**. – **Chiang Mai Province**, Doi Inthanon NP, Checkpoint 2, 18°31.554'N 98°29.94'E, 1700 m, 24.xi.-1.xii.2006, ex. Malaise trap, coll: Y. Areeluck (T1870) (1♂, CSCA; 1♂, QSBG). – Doi Inthanon NP, Vachiratharn Falls, 18°32.311'N 98°36.048'E, 700 m, 29.vi.-2.vii.2006, ex. Malaise trap, coll: Y. Areeluck (T40) (1♂, USNM). –Doi Suthep-Pui National Park, What Phrathat, 1050m, 18.48N/98.55E, 30.XII.2005, P. Schwendinger (1♂, MHNG).

DISTRIBUTION: China (Yunnan), new record to Thailand.

Noonamyia bipunctata sp. n. Figs 11-15, Plate B3

MATERIAL: HOLOTYPE ♂ (CAUC): China, Guangxi Province, Jinxiu, Dayaoshan National Nature Reserve, Longjunshan, 240-700 m, 27.32N/111.58E, 29.VII.2005, Yajun Zhu. PARATYPE: **CHINA**. – **Guangxi Province**, Jinxiu, Dayaoshan National Nature Reserve, Longjunshan, 240-700 m, 27.32N/111.58E, 29.VII.2005, Yajun Zhu (1♀, CAUC).

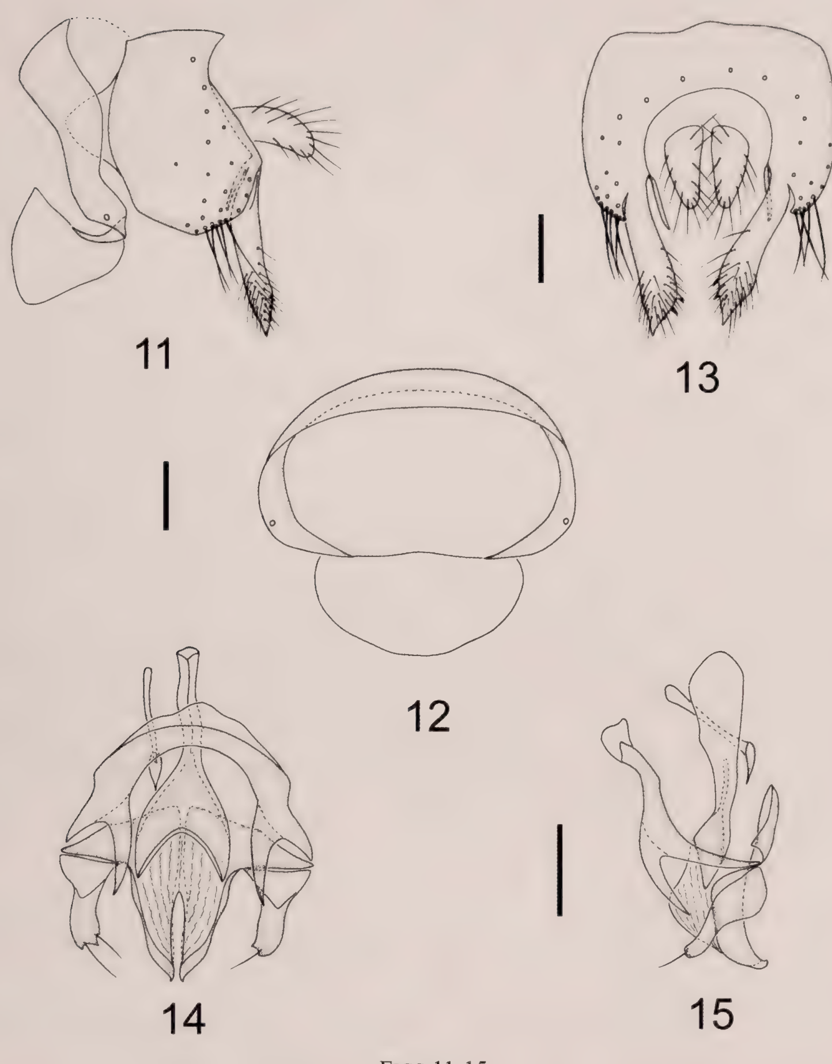
ETYMOLOGY: Latin, *bi-*, prefix meaning two + *punctata*, meaning spotted, referring to the wing with two round hyaline spots in cell r_{4+5}; a feminine adjective.

DIAGNOSIS: Antennal 1st flagellomere yellow, except brown on apical 1/3. Palpus brown. Mid and hind femora with a pair of brown lateral spots at tip, tarsomeres 4-5 pale brown. Wing with a hyaline stripe extending downward from Costa to CuA_1 before vertical level of *r-m*, separated from a short hyaline stripe in cell cua_1; two round hyaline spots in cell r_{4+5}, a hyaline apical stripe between R_{4+5} and M_1; no spots on *r-m* and *dm-cu*; subcostal cell brown. Abdominal tergites 1-2 yellow with a brown transverse median band on tergite 2, and tergites 3-6 black.

DESCRIPTION

Length: Body 3.1 mm, wing 3.0 mm.

Head yellow. Frons about as long as wide and parallel–sided, with 2 brown stripes extending to ocellar triangle; ocellar triangle black; oc and or broken. Face pale yellow, with a pair of shining brown spots at ventral corner. Gena about 1/5 height of eye. Antenna yellow, except 1st flagellomere brown on apical 1/3, 2.0 times longer than high; arista blackish brown, plumose, with longest setula slightly longer than height of 1st flagellomere. Proboscis yellow, with yellowish and blackish setulae; palpus pale brown, with blackish setulae.



FIGS 11-15

Noonamyia bipunctata sp. n., male holotype. (11) Epandrium and protandrium, lateral view. (12) Protandrium, anterior view. (13) Epandrium, posterior view. (14) Aedeagal complex, ventral view. (15) Aedeagal complex, lateral view. Scale 0.1 mm

Thorax blackish brown except yellow on basal 1/4. Mesonotum with 0+3 *dc*, *acr* in 6 rows. 1 *anepst*, 1 *kepst*. Scutellum entirely yellow.

Legs yellow. Mid and hind femora with a pair of brown lateral spots at tip, tarsomeres 4-5 pale brown. Fore femur with 3 *pv* and 4 *pd*, ctenidium with 9 short setulae; fore tibia with 1 weak preapical ad and 1 *apv*. Mid femur with 4 *a*; mid tibia with 1 preapical *ad* and 2 strong *apv*. Hind femur with a row of weak *av*; hind tibia with 1 weak preapical *ad* and 1 short *apv*.

Wing (Plate B3) with a hyaline stripe extending downward from Costa to CuA_1 before vertical level of *r-m*, separated from a short hyaline stripe in cell cua_1; two round hyaline spots in cell r_{4+5}, a hyaline apical stripe between R_{4+5} and M_1; no spots on *r-m* and *dm-cu*; subcostal cell brown; Costa with 2nd (between R_1 and R_{2+3}), 3rd (between R_{2+3} and R_{4+5}) and 4th (between R_{4+5} and M_1) sections in proportion of 1.5 mm : 0.5 mm : 0.4 mm; *r-m* beyond middle of distal cell; ultimate and penultimate sections of M_1 in proportion of 1.0 mm : 1.1 mm; ultimate section of CuA_1 about 1/5 of penultimate. Halter pale yellow.

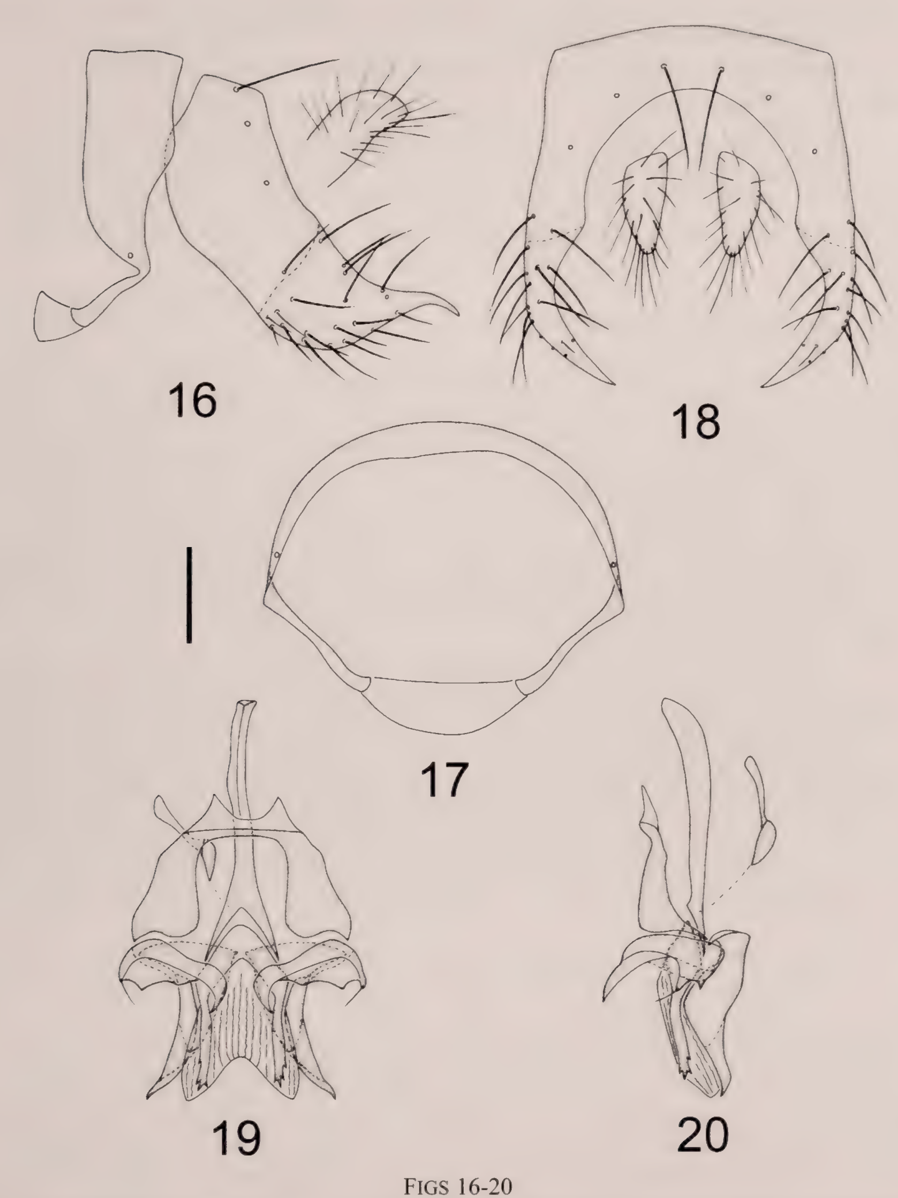
Abdominal tergites 1-2 yellow, with a brown transverse median band on tergite 2; tergites 3-6 black and protandrium and epandrium yellow. Male genitalia (Figs 11-15): protandrium semicircular; epandrium U-shaped in ventral view, with long setae on ventral margin; surstylus consisting of a short claviform process and a long subuliform process with three teeth and many setulae; hypandrium V-shaped with a pair of knife-like processes; gonopod short, wide with two or three teeth and one or two apical setae in ventral view; aedeagus curved apically, with a pair of triangular basal processes in ventral view; aedeagal apodeme Y-shaped, longer than aedeagus.

REMARKS: The new species is similar to *Noonamyia lyneborgi* Stuckenberg from the Philippines (Palawan Island) in the wing with two round hyaline spots in cell r_{4+5}, abdomen with tergites 1-2 yellow and tergites 3-6 black. But it can be separated from the latter by the fore tibia having 1 weak preapical *ad*, the wing having a hyaline stripe extending downward from Costa to CuA_1 and separated from a short hyaline stripe in cell cua_1, the surstylus consisting of a short claviform process and a long subuliform process with three teeth and many setulae. In *N. lyneborgi*, the fore tibia has no preapical *ad*; the wing has a complete hyaline stripe extending from costal margin to posterior margin before the vertical level of *r-m*; the surstylus has a tiny apical tooth (Stuckenberg, 1971; Sasakawa & Pong, 1990).

DISTRIBUTION: China (Guangxi).

Noonamyia flavoscutellata sp. n. Figs 16-20, Plate B4

MATERIAL: HOLOTYPE ♂ (CAUC): China, Guangxi Province, Jinxiu, Dayao Mountain, Yinshan, 1000 m, 27.VII.2005, Yajun Zhu. PARATYPES: **CHINA**. – **Guangxi Province**, Jinxiu, Dayaoshan National Nature Reserve, Longjunshan, 240-700 m, 27.32N/111.58E, 29.VII.2005, Yajun Zhu (1♀, CAUC). **THAILAND**. – **Chiang Mai Province**, Doi Inthanon National Park, 750 m, 26.XII.2001, P. Schwendinger (2♂♂, MHNG). – Doi Pha Hom Pok W of Fang, 1500 m, 20.02.43N/99.08.43E, P. Swendinger (2♂♂, MHNG). – Doi Suthep-Pui National Park, Huay Khok Ma, 19.XII.2001, P. Schwendinger (4♂♂, 4♀♀, MHNG; 3♂♂, 3♀♀, USNM). – Doi Suthep-Pui National Park, nr Doi Suthep summit, 1550 m, 18.82N/98.89E, 26.X.2000, B. Merz & P. Schwendinger (3♂♂, 3♀♀, MHNG). – Doi Suthep-Pui National Park, 1420 m, 18.50.09N/98.53.47E, 18.XII.2001, P. Schwendinger (1♂, 1♀, CAUC). – Doi Suthep, Huay Khok Ma, 1300 m, 18.48/N98.55E, 26.XII.2006, P. Schwendinger (1♂, 1♀, MHNG). – Doi Suthep-Pui National Park, Palad Trail, 4-800 m, 18.79N/98.93E, 16.X.2000, B. Merz & P. Schwendinger (1♂, MHNG). – Doi Suthep-Pui National Park, nr Phuphing Palace, 1250 m, 18.80N/98.90E, 26.X.2000, B. Merz & P. Schwendinger (4♂♂, 1♀, MHNG; 2♂♂, CSCA). – Doi Suthep-Pui National Park, What Phrathat, 900 m, 18.80N/98.92E, 16.X.2000, B. Merz & P. Schwendinger (2♂♂, 5♀♀, MHNG; 2♀♀, CSCA). – Doi Suthep-Pui National Park, What Phrathat, 950m, 18.80N/98.92E, 19.X.2000, B. Merz & P. Schwendinger (1♂, 2♀♀, MHNG; 1♂, 3♀♀, CAUC). – Doi Suthep-Pui National Park, What Phrathat, 1050m, 18.48N/98.55E, 30.XII.2005, P. Schwendinger (1♂, MHNG). – Doi Suthep-Pui



FIGS 16-20

Noonamyia flavoscutellata sp. n., male paratype. (16) Epandrium and protandrium, lateral view. (17) Protandrium, anterior view. (18) Epandrium, posterior view. (19) Aedeagal complex, ventral view. (20) Aedeagal complex, lateral view. Scale 0.1 mm.

National Park, What Phrathat, 1100m, 18.80N/98.92E, 19.X.2000, B. Merz & P. Schwendinger (2♂♂, 3♀♀, MHNG). – Doi Suthep-Pui National Park, What Phrathat, 1200m, 18.80N/98.92E, 1.XI.2000, B. Merz & P. Schwendinger (3♂♂, 2♀♀, MHNG). – Doi Suthep, 1150-1300 m, 20-28.XII.2003, P. Schwendinger (3♂♂, 6♀♀, MHNG; 1♂, 1♀, CAUC; 3♂♂, 3♀♀, CSCA). – **Lamphun Province**, Doi Khuntan National Park, 45km SE Chiang Mai, 650m, 18.50.N/99.27E,

2.XI.2000, B. Merz & P. Schwendinger (1♂, MHNG). **VIETNAM**. – **Kien Giang Province**, Phu Quoc Island, 250m, 10.23N/104.01E, 14-16.VIII.2003, P. Swendinger (1♂, MHNG).

ETYMOLOGY: Latin, *flav-*, prefix meaning yellow + *scutellata*, referring to the scutellum; a feminine adjective.

DIAGNOSIS: Antennal 1st flagellomere pale brown. Palpus brown except for pale yellow at third. Wing with a short hyaline stripe in cell cua_1; an elliptical hyaline spot in cell r_{4+5}, a semicircular hyaline apical stripe between R_{2+3} and CuA_1, confluent with a digitiform hyaline stripe beyond *dm-cu*; a narrow pale brown stripe on *r-m*.

DESCRIPTION

Length: Body 2.1-2.8 mm (male), 2.2-2.8 mm (female); wing 3.0-3.5 mm (male), 3.0-3.3 mm (female).

Head yellow. Frons as long as wide and parallel-sided, with 2 brown stripes extending to ocellar triangle; ocellar triangle black; *oc* strong, as long as anterior *or* and anterior *or* shorter than posterior *or*. Face pale yellow, with a pair of shining brown lateral spots at ventral corner. Gena about 1/9 height of eye. Antennal scape brownish yellow, pedicel yellow and 1st flagellomere pale brown except yellow on base part of ventral margin, 1st flagellomere nearly 1.8 times longer than high; arista long plumose, black except for brownish base, with longest setula longer than height of 1st flagellomere. Proboscis yellow, with yellow and blackish setulae; palpus brown except for pale yellow at third, with black setulae.

Thorax blackish brown, slightly shining with sparse grayish white pruinosity. Mesonotum with broad yellow anterior margin; 0+3 *dc*, *acr* in 6 rows; *prsc* broken. 1 *anepst*, 1 *kepst*. Scutellum entirely yellow. Halter pale yellow except brown knob.

Legs yellow, except fore tibia slightly brownish yellow, mid and hind femora brown at tip, mid tibia brown on basal 1/2-2/3 and all tarsomeres 3-5 pale brown. Fore femur with 2 *pv* and 6 *pd*, ctenidium with 9-10 short setulae; fore tibia with 1 weak preapical *ad* and 1 *apv*. Mid femur with 4 *a*; mid tibia with 1 preapical *ad* and 2 strong *apv*. Hind femur with a row of weak *av*; hind tibia with 1 weak preapical *ad* and 1 short *apv*.

Wing (Plate B4) mostly brown, with a triangular hyaline stripe extending downward from Costa to M_1, a short hyaline stripe in cell cua_1; an elliptical hyaline spot in cell r_{4+5}, a semicircular hyaline apical stripe between R_{2+3} and CuA_1, confluent with a digitiform hyaline stripe beyond *dm-cu*; a narrow pale brown stripe on *r-m* and a tinged brown triangular stripe over *dm-cu*, extending to the tip of CuA_1; apical part of subcostal cell brown; Costa with 2nd (between R_1 and R_{2+3}), 3rd (between R_{2+3} and R_{4+5}) and 4th (between R_{4+5} and M_1) sections in proportion of 1.9 mm : 0.6 mm : 0.5 mm; *r-m* beyond middle of distal cell; ultimate and penultimate sections of M_1 in proportion of 1.0 mm : 1.0 mm; ultimate section of CuA_1 about 1/5 of penultimate.

Abdomen blackish brown, slightly shining with sparse grayish white; protandrium and epandrium yellow. Male genitalia (Figs 16-20): protandrium semicircular; epandrium U-shaped in ventral view; surstylus short, curved downward; hypandrium U-shaped, gonopod transverse broad, undulating ventral margin with 1 apical seta in ventral view; aedeagus consisting of a small incision, a pair of triangular basal processes, an arch-like ventral sclerite with apical teeth and a pair of dorsal sclerites with acuate apical processes; aedeagal apodeme Y-shaped, longer than aedeagus.

REMARKS: The new species is very similar to *Noonamyia sasakawai* Papp from Thailand in the following characters: the wing has an incomplete hyaline stripe before the base of *r-m*, it lacks a round hyaline spot in cell dm, it has a semicircular hyaline marginal stripe between the tips of R_{4+5} and CuA_1, the hind tibia has a short preapical *ad*, the scutellum is entirely yellow or brownish yellow, and the surstylus is acuate apically and curved backward. The new species differs from *Noonamyia saskawai* in details of the genitalia, particularly the epandrium having 3-4 long dorsal setae, and the gonopod having an undulating ventral margin and an apical seta. In *Noonamyia sasakawai*, the epandrium has 2 long dorsal setae and the gonopod is comma-like with a straight ventral margin and 1-2 subapical setae ventrally. The new species is also similar to *Noonamyia euphlebia* Sasakawa & Pong from Malaysia and Thailand in the following characters: legs with fore tibia slightly brownish yellow, mid and hind femora brown at tip and wing with an incomplete hyaline stripe before base of *r-m*. But it can be separated from the latter by the mid tibia brown on basal 1/2-2/3, the scutellum being yellow, the semicircular hyaline marginal stripe being present, and the epandrium with 3-4 pairs of dorsal setae. In *Noonamyia euphlebia*, the mid tibia is entirely brown, the scutellum is brownish black, the brown area in cell m_1 almost extends to the margin of wing but does not form a marginal stripe around to CuA_1, and the epandrium has 5-6 pairs of dorsal setae (Sasakawa & Pong, 1990; Sasakawa, 1998).

DISTRIBUTION: China (Guangxi), Thailand, Vietnam.

Noonamyia sabahna Sasakawa & Pong, 1990

Noonamyia sabahna Sasakawa & Pong, 1990: 32. Type locality: Malaysia (Sabah).

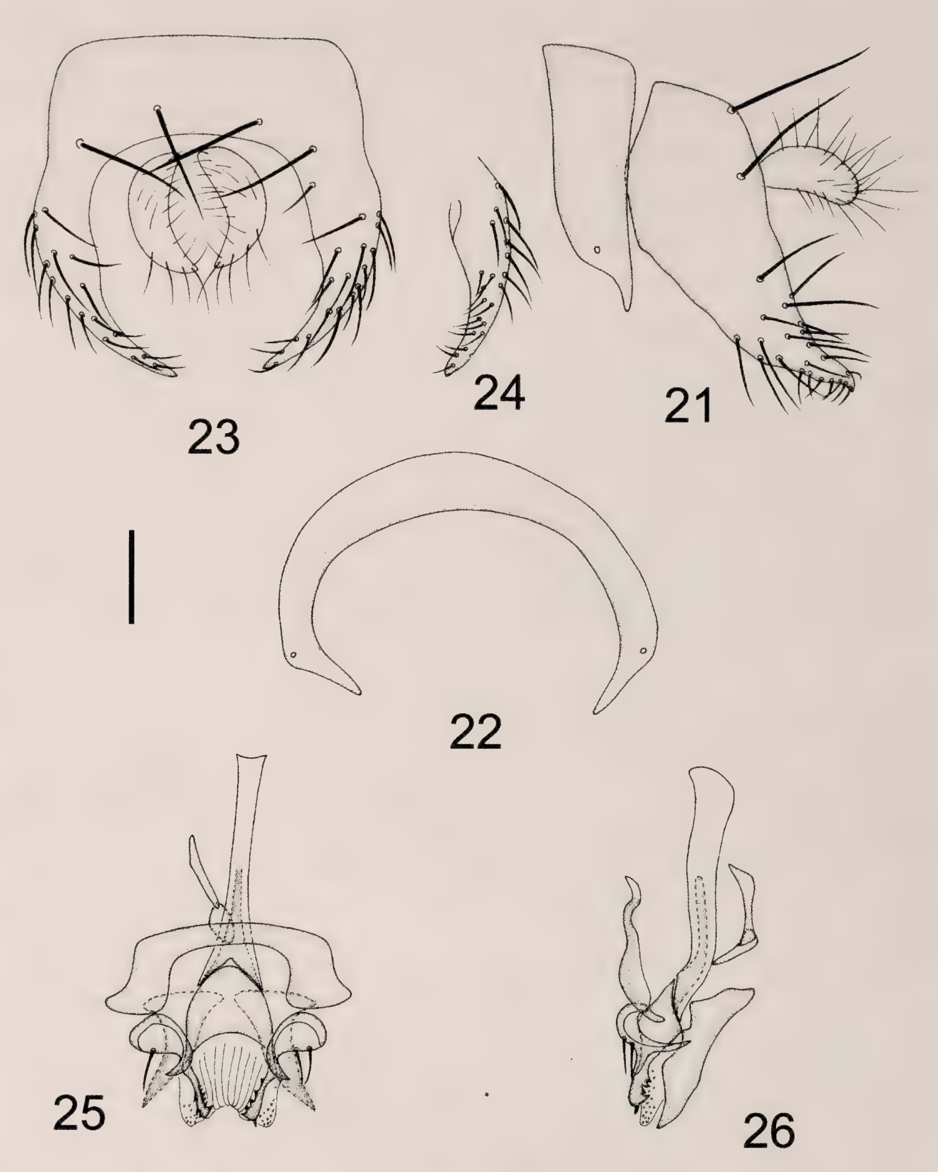
MATERIAL: PHILIPPINES. – Mindanao, Agusan del Sur, 10 km SE San Francisco, 12.IX.1959, coll: L.W. Quate (1 (sex unknown), BPBM); Misamis Oriental, Minubana, 1050-1200 m, 5-9.IV.1961, coll: H. Torrevillas (1 (sex unknown), BPBM).

DISTRIBUTION: Malaysia (Sabah), new record to the Philippines.

Noonamyia sasakawai Papp, 2006 Figs 21-26, Plates C1-C5

Noonamyia sasakawai Papp, in Papp, Merz & Földvári, 2006: 185. Type locality: Thailand (Doi Pui).

MATERIAL: PARATYPES: **THAILAND**. – **Nan Province**, Tham Sakoen NP, 19°23′N/100°38′E, No. 17, over and along creek in forest, 26.XI.2003, M. Földvári & A. Szappanos (1♂, HNHM). – Doi Phuka NP, No. 18, UV light, 26-27.XI.2003, L. Peregovits, M. Földvári, Á. Kőrösi, A. Szappanos & B. Maklári-Kis (1♀, HNHM). ADDITIONAL MATERIALS: **THAILAND**. – **Chiang Mai Province**, Chiang-dao, 5-11.IV.1958, T.C. Maa (1♂, BPBM). – **Loei Province**, Phu Kradueng NP, Savannah in pine forest, 16°53.092'N 101°47.413'E, 1257 m, 30-31.xii.2006, ex. pan traps, coll: Sutin Gongla-sae (T1215) (1♀, QSBG). – Phu Ruea NP, Ma Kraow ditch, 17°29.652'N 101°21.020'E, 1167 m, 5-12.xi.2006, ex. Malaise trap, coll: Patikhom Tumtip (T1116) (1♀, QSBG). – Phu Ruea NP, Ma Kraow ditch, 17°29.652'N 101°21.020'E, 1167 m, 7-8.xi.2006, pan traps, Patikhom Tumtip (T1110) (1♂, 1♀, USNM). – Phu Ruea NP, Ma Kraow ditch, 17°29.652'N 101°21.020'E, 1167 m, 8-9.xi.2006, ex. pan trap, coll: Patikhom Tumtip (T1111) (1♀, QSBG). – Phu Ruea NP, Ma Kraow ditch, 17°29.652'N 101°21.020'E, 1167 m, 10-11.xi.2006, ex. pan trap, coll: Patikhom Tumtip (T1113) (1♂, QSBG). – Phu Ruea NP, office, 17°28.826'N 101°21.330'E, 860 m, 7-8.vii.2006, ex. pan trap, coll: Patikhom Tamtip (T305) (2♂♂, CSCA). – Phu Ruea NP, Pan Hin Khan Maak ditch, 17°30.042'N 101°20.474'E, 1219 m, 6-7.ii.2007, ex. pan trap, coll: Patikhom Tumtip (T1699) (1♀, CSCA). – Phu Ruea NP, Pan Hin Khan Maak ditch, 17°30.042'N 101°20.474'E, 1219 m, 8-9.ii.2007, ex. pan trap, coll:



FIGS 21-26

Noonamyia sasakawai Papp, 2006, male paratype. (21) Epandrium and protandrium, lateral view. (22) Protandrium, anterior view. (23) Epandrium, posterior view. (24) Surstylus, anterior view. (25) Aedeagal complex, ventral view. (26) Aedeagal complex, lateral view. Scale 0.1 mm.

Patikhom Tumtip (T1701) (1♂, CSCA). – **Phetchabun Province**, Nam Nao NP, Heliport, 16°43.156'N 101°35.118'E, 890 m, 18-19.xii.2006, ex. pan trap, coll: Noopean Hongyothi & Leng Janteab (T1425) (1♀, QSBG). – Nam Nao NP, Heliport, 16°43.156'N 101°35.118'E, 890 m, 20-21.xii.2006, ex. pan trap, coll: Noopean Hongyothi & Leng Janteab (T1427) (1♂ 1♀, QSBG). – Nam Nao NP, Tham Pra Laad Forest Unit, 16°44.963'N 101°27.833'E, 711 m, 4-5.vi-

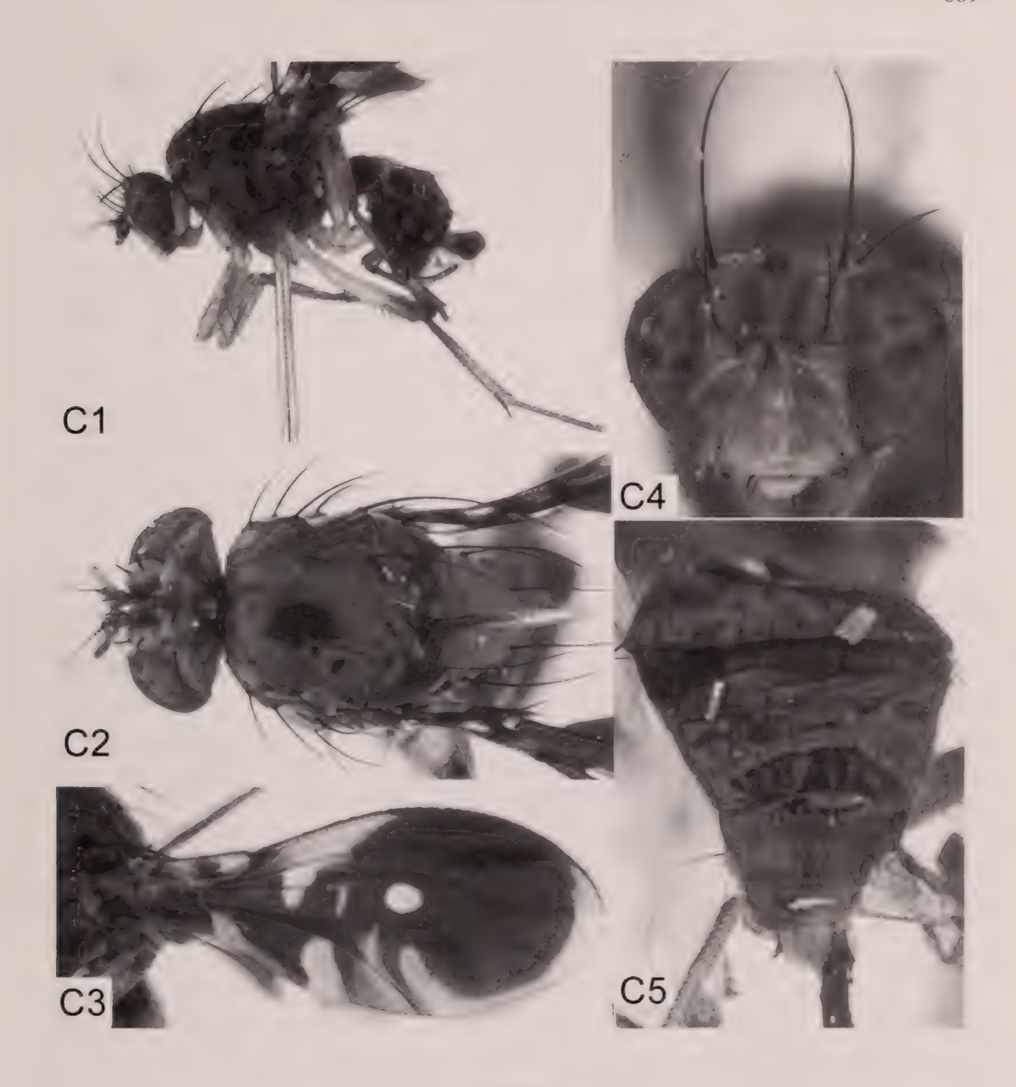


PLATE C

Noonamyia sasakawai Papp, 2006, male paratype. (1) Habitus, lateral view. (2) Mesonotum, dorsal view. (3) Wing. (4) Head, anterior view. (5) Abdomen, dorsal view.

ii.2006, ex. pan trap, coll: Noopean Hongyothi & Leng Janteab (T417) (1♀, QSBG). – **Phitsanulok Province**, Thung Salaeng Luang NP, Dry evergreen, 16°50.217'N 101°52.541'E, 580 m, 11-12.viii.2006, ex. pan trap, coll: Pongpitak Pranee (T559) (1♀, CSCA). – Thung Salaeng Luang NP, Dry evergreen, 16°50.217'N 101°52.541'E, 580 m, 13-19.viii.2006, ex. pan trap, coll: Pongpitak Pranee (T562) (1♀, CSCA). **VIETNAM**. – **Lam Dong Province**, – 6 km S of Dalat, 1550 m, 12.IX.1960, J.L. Gressitt (1♂, CSCA). Fyan, 900-1000 m, 11.VII-9.VIII.1961, N.R. Spencer (1♂, USNM). – Di Lihn (Djiring), 27.IX-14.X.1960, C.M. Yoshimoto (1♂, BPBM). – Fyan, 1200 m, 11.VII-9.VIII.1961, N.R. Spencer (1♂, 1♀, BPBM).

DIAGNOSIS: Antenna brownish yellow, 1st flagellomere brown on apical 1/2. Palpus brown except for yellow basal 1/4. Wing with a short hyaline stripe in cell cua_1;

an elliptical hyaline spot in cell r_{4+5}, a semicircular hyaline apical stripe between R_{2+3} and CuA_1; a narrow hyaline stripe on *r-m* and a pale brown triangular stripe over *dm-cu*, extending to the tip of CuA_1.

DESCRIPTION

Length: Body 2.5 mm (male), 2.5 mm (female); wing 2.9 mm (male), 3.0 mm (female).

Head (Plate C4) yellow. Frons with 2 brown stripes extending from anterior margin to ocellar triangle, slightly wider than long and parallel-sided; ocellar triangle black; *oc* strong, as long as posterior *or* and anterior *or* about 1.5 times as long as posterior *or*. Face white, with a pair of shining blackish brown lateral spots at ventral corner. Gena about 1/9 height of eye. Antenna brownish yellow, 1st flagellomere brown on apical 1/2, 1.5 times longer than high; arista long plumose, black except for brownish base, with longest setula longer than height of 1st flagellomere. Proboscis yellow, with yellowish and blackish setulae; palpus brown except for yellow basal 1/4, with black setulae.

Thorax (Plate C2) blackish brown with sparse grayish white pruinosity. Mesonotum with broad yellow anterior margin; 0+3 *dc*, *acr* in 6 rows. Scutellum entirely brownish yellow.

Legs pale yellow to yellow except mid and hind tibiae brown at tip, mid tibia blackish brown on basal 1/3-1/2 and all tarsomeres 4-5 pale brown. Fore femur with 2 *pv* and 6 *pd*, ctenidium with 9-10 short setulae; fore tibia with 1 weak preapical *ad* and 1 *apv*. Mid femur with 4 *a*; mid tibia with 1 preapical *ad* and 2 strong *apv*. Hind femur with 3 *av* on apical 1/2; hind tibia with 1 weak preapical *ad* and 1 short *apv*.

Wing (Plate C3) with a triangular hyaline stripe extending downward from Costa to M_1 before vertical level of *r-m* and a narrow hyaline stripe in cell cua_1; an elliptical hyaline spot in cell r_{4+5}, a semicircular hyaline apical stripe between R_{2+3} and CuA_1; a narrow hyaline stripe on *r-m* and a pale brown triangular stripe over *dm-cu*, extending to the tip of CuA_1; subcostal cell brown at tip; Costa with 2nd (between R_1 and R_{2+3}), 3rd (between R_{2+3} and R_{4+5}) and 4th (between R_{4+5} and M_1) sections in proportion of 1.7 mm : 0.5 mm : 0.4 mm; *r-m* beyond middle of distal cell; ultimate and penultimate sections of M_1 in proportion of 1.2 mm : 1.0 mm; ultimate section of CuA_1 about 1/3 of penultimate. Halter pale yellow except knob brown on basal 1/2.

Abdomen (Plate C5) black, with sparse grayish white pruinosity; protandrium and epandrium brownish yellow. Male genitalia (Figs 21-26): protandrium semi - circular; epandrium with two pairs of long dorsal setae in ventral view; surstylus short, curved downward with several setae; hypandrium U-shaped; gonopod comma-like with 1-2 long setae in ventral view; aedeagus consisting of a shallow incision, a pair of slender ventral sclerites with several small acuate processes, membranous part with many tiny teeth and a pair of dorsal sclerites with acuate apical processes; aedeagal apodeme Y-shaped, longer than aedeagus.

REMARKS: This species is very similar to *Noonamyia flavoscutellata* sp. n. and the differentiating characteristics of the two species are reflected in the key and in the remarks for the latter species.

DISTRIBUTION: Thailand, new record to Vietnam.

KEY TO SEPARATE SPECIES OF THE GENUS *NOONAMYIA* IN THE WORLD

(The following key is based on the key by Sasakawa & Pong (1990) with the new species integrated at the appropriate couplets)

1a Wing with a complete white stripe before *r-m*, running vertically through whole wing 2
1b Wing without complete white stripe before *r-m* 4
2a Wing with 1-2 small white round spots in cell r_{4+5} 3
2b Wing only with a wide white stripe in cell r_{4+5} (see Frey, 1958: fig. 11). Distributed in Philippines . . . . . *N. fascipennis* (Frey, 1958)
3a Wing with one white round spot in cell r_{4+5}; katepisternum pale yellow; fore tibia without preapical *ad*; surstylus consisting of two processes (see Sasakawa & Pong, 1990: figs 5A, 6-7). Distributed in Malaysia . . . . . *N. abdominalis* Sasakawa & Pong, 1990
3b Wing with two white round spots in cell r_{4+5}; katepisternum brownish black; fore tibia with preapical *ad*; surstylus unique, with an acuate apical tooth (see Stuckenberg, 1971: figs 59, 87). Distributed in Philippines . . . . . *N. lyneborgi* Stuckenberg, 1971
4a Wing with a round hyaline spot in cell dm; epandrium with a short posterior process and surstylus striate (see Sasakawa & Pong, 1990: figs 5C, 8-9). Distributed in Malaysia, Philippines . . . . . *N. sabahna* Sasakawa & Pong, 1990
4b Wing without spot in cell dm; epandrium and surstylus not as above 5
5a Wing without spot in cell r_{4+5}, only with two white stripes passed through cell r_{4+5} (see Frey, 1958: fig. 10). Distributed in Philippines . . . . . *N. irregularis* (Frey, 1958)
5b Wing with 1-2 white round or elliptical spots in cell r_{4+5} 6
6a Hind tibia without preapical *ad* 7
6b Hind tibia with a short preapical *ad* 9
7a Wing with two narrow white stripes situated around *r-m* 8
7b Wing with a wide white stripe before *r-m* (see Okadome, 1982: fig. 1). Distributed in Philippines . . . . . *N. chujoi* Okadome, 1982
8a Wing with a white U-shaped spot surrounding *r-m* and a white triangular spot in cell m_1 before vertical level of a white round spot in cell r_{4+5} (see Stuckenberg, 1971: fig. 58). Distributed in Philippines . . . . . *N. palawanensis* Stuckenberg, 1971
8b Wing without U-shaped spot surrounding *r-m*, a white triangular spot in cell m_1 at same vertical level with a white round spot in cell r_{4+5} (see Sasakawa & Pong, 1990: fig. 5D). Distributed in Malaysia . . . . . *N. pleuralis* Sasakawa & Pong, 1990
9a Wing without white or hyaline spot or stripe on *r-m* and *dm-cu*, two white spots beyond *r-m* in cell r_{4+5} (Plate B3). Distributed in Southern China . . . . . *N. bipunctata* sp. n.
9b Wing with white or hyaline spot or stripe on *r-m* and *dm-cu*, one white spot beyond *r-m* in cell r_{4+5} 10

10a Wing with a semicircular hyaline marginal stripe between tips of R_{4+5} and CuA_1; scutellum entirely yellow or brownish yellow 11
10b Wing without semicircular hyaline marginal stripe between tips of R_{4+5} and CuA_1; scutellum at least black or brown on basal 1/2 13
11a Cross vein *r-m* with a pale brown spoon-like spot; surstylus with two subuliform processes; gonopod with two acuate furcated apical processes in ventral view (see Shi & Yang, 2009: figs 1, 6). Distributed in Southern China . . . . *N. bisubulata* Shi & Yang, 2009
11b Cross vein *r-m* without pale brown spoon-like spot; surstylus acuate apically and curved backward; gonopod not as above 12
12a Epandrium with 3-4 long dorsal setae; gonopod with undulating ventral margin and an apical seta in ventral view (Figs 18, 19). Distributed in Southern China, Thailand, Vietnam . . . . *N. flavoscutellata* sp. n.
12b Epandrium with 2 long dorsal setae; gonopod comma-like with straight ventral margin and 1-2 subapical setae in ventral view (Figs 23, 25). Distributed in Thailand, Vietnam . . . . *N. sasakawai* Papp, 2006
13a Wing with a narrow hyaline stripe on *r-m*; gonopod acinaciform and membranous area of aedeagus with small teeth in ventral view (see Sasakawa & Pong, 1990: fig. 5B; Sasakawa, 1998: fig. 2B). Distributed in Laos, Malaysia, Thailand, Vietnam . . *N. euphlebia* Sasakawa & Pong, 1990
13b Wing with a pale brown umbrella-like spot on *r-m*; gonopod spoon-like and membranous area of aedeagus without small teeth in ventral view (see Shi & Yang, 2009: figs 2, 12). Distributed in Southern China . . . . *N. umbrellata* Shi & Yang, 2009

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On the Scaphisomatini (Coleoptera: Staphylinidae: Scaphidiinae) of the Philippines, II

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On the Scaphisomatini (Coleoptera: Staphylinidae: Scaphidiinae) of the Philippines, II - The Philippine species of *Scaphobaeocera* and *Xotidium* are reviewed and a key to the species of *Scaphobaeocera* is provided. The following new species are described: *Scaphobaeocera bulbosa* sp. n., *S. complicans* sp. n., *S. data* sp. n., *S. davaoana* sp. n., *S. episternalis* sp. n., *S. escensa* sp. n., *S. excisa* sp. n., *S. hamata* sp. n., *S. monticola* sp. n., *S. montivagans* sp. n., *S. orousseti* sp. n., *S. palawana* sp. n., *S. pseudotenella* sp. n., *S. pubiventris* sp. n., *S. serpentis* sp. n., *S. watrousi* sp. n., *S. werneri* sp. n., and *Xotidium tubuliferum* sp. n. *Scaphobaeocera sabapensis* Löbl is reported for the first time from the Philippines.

Keywords: Coleoptera - Staphylinidae - Scaphidiinae - Scaphisomatini - taxonomy - Philippines

INTRODUCTION

The present paper deals with the Philippine species of *Scaphobaeocera* Csiki, 1909 and *Xotidium* Löbl, 1992, both belonging to the *Baeocera* group (see Leschen & Löbl, 2005). Members of these two genera have the body laterally compressed and the ventrites are highly vaulted, both features correlated with approximate metacoxae. The third and more species-rich genus of the group occurring in the Philippines, *Baeocera* Erichson, 1845, will be treated in a separate study. These three genera share two unreversed synapomorphies: aciculate maxillary palpi and the presence of prothoracic corbicula. While *Baeocera* is almost cosmopolitan in distribution, *Scaphobaeocera* is absent from the New World and occurs mainly in the tropics and subtropics of Asia. Members of *Scaphobaeocera* are commonly found in samples of moist forest litter and rotten wood and are according to the so far available observations myxomycetophagous. *Xotidium* is a poorly known group of a few tropical species. Data on their host preferences are not available.

Both, *Scaphobaeocera* and *Xotidium*, may be distinguished from other Scaphisomatini genera by keyes given in Löbl (1992) and Leschen & Löbl (2005). Most species of *Scaphobaeocera* have elytra iridiscent and each with a fine parasutural stria. Eventually also other body parts are iridescent, due to the presence of fine, transversely striate microsculpture. These features are unknown in other Scaphisomatini.

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MATERIAL AND METHODS

Most of the material dealt with in the present study was found in samples of forest litter and rotten wood, and extracted in winkler-moczarski or berlese devices. The specimens studied are housed in the following institutions:

FMNH Field Museum of Natural History, Chicago
MHNG Muséum d'histoire naturelle, Geneva
SMNS Staatliches Museum für Naturkunde, Stuttgart

The methods are as in Löbl (1992). The species of *Scaphobaeocera* are given below in alphabetic order, for convenience and because species groups were not yet defined within the genus.

TAXONOMY

Scaphobaeocera Csiki, 1909

This genus comprises 77 species currently recognized as valid. Its range covers large parts of tropical and subtropical Asia, extending to warm temperate areas of Far East Russia, the Pacific islands, Australia, Africa, Seychelles and the Mascarene archipelago. Only one species, *S. minutissima* (Löbl, 1969), was so far reported from the Philippines (Löbl, 1969, 1972, 1997). It is notable that this species was absent from extensive modern collections. It was based on a single specimen found in an old collection that comes, according to its label data, from Mount Makiling. *Scaphobaeocera* appears particularly diverse on Mount Makiling where eight of the 19 Philippine species were found. However, this fact may be explained rather by the more intensive field work in the easily accessible sites of that mountain than by diversity patterns.

KEY TO THE PHILIPPINE SPECIES OF *SCAPHOBAEOCERA*

1 Antennomere VII longer than antennomeres IV to VI combined and more than 5 times as long as antennomere VIII . . . . *S. escensa* sp. n.
- Antennomere VII much shorter than antennomeres IV to VI combined and much less than 5 times as long as antennomere VIII 2
2 Antennomere XI about 2 or 2.5 times as long as antennomere X and about 3 to 5 times as long as wide 3
- Antennomere XI about 1.2 to 1.5 times as long as antennomere X and about 2 to 3 times as long as wide 7
3 Hypomeron lacking stria . . . . *S. palawana* sp. n.
- Hypomeron with longitudinal stria 4
4 Elytra microsculptured and usually iridescens 5
- Elytra not microsculptured and not iridescent. Aedeagus without spiral flagellum 6
5 Small species 1.0 mm long. Lateral parts of metaventrite distinctly punctate. Basolateral parts of abdominal ventrite 1 not microsculptured. Aedeagus with flagellum simple, spiral . . . . *S. minutissima* (Löbl)
- Medium-sized species 1.3-1.4 mm long. Lateral parts of metaventrite extremely finely punctate. Entire abdominal ventrite 1 distinctly micro - sculptured . . . . *S. montivagans* sp. n.

6 Abdominal ventrite 1 with microsculpture consisting of transverse striae. Aedeagus with simple internal sac . . . . *S. watrousi* sp. n.
- Abdominal ventrite 1 lacking microsculpture. Aedeagus with complex internal sac . . . . *S. complicans* sp. n.
7 Elytra with sutural striae extending along basal margins. Punctures margining mesocoxal lines coarse and extended laterally along mesepimera . . . . *S. excisa* sp. n.
- Elytra with sutural striae not extending along basal margins. Punctures margining mesocoxal lines not extending laterally and usually very fine 8
8 Hypomeron with longitudinal stria. Male with apicomedian surface of metasternum completely covered by conspicuously dense patch of pubescence . . . . *S. pubiventris* sp. n.
- Hypomeron lacking stria. Male with pubescence not completely covering apicomedian surface of metasternum 9
9 Elytra with sutural striae shortened, starting clearly posterior pronotal lobe . . . . *S. monticola* sp. n.
- Elytra with sutural striae starting near basal margins and usually curved along pronotal lobe 10
10 Thorax and elytra lacking obvious microsculpture, not iridescent 11
- Thorax and/or elytra microsculptured, elytra usually distinctly iridescent . . . 13
11 Metepisterna about 0.05 mm wide, with straight suture. Punctures bordering mesocoxal lines fine . . . . *S. davaoana* sp. n.
- Metepisterna about 0.08-0.14 mm wide, with arcuate suture. Punctures bordering mesocoxal lines coarse 12
12 Elytra with parasutural striae. Antennomere VIII about 2.5 times as long as wide. Metepisterna conspicously large, 0.10-0.14 mm wide, with suture strongly arcuate . . . . *S. episternalis* sp. n.
- Elytra without parasutural striae. Antennomere VIII conspicuously small, only slightly longer than wide. Metepisterna 0.08-0.10 mm wide, with suture weekly arcuate . . . . *S. serpentis* sp. n.
13 Median lobe of aedeagus without prominent ventral processes or tubercles . 14
- Median lobe of aedeagus with prominent ventral processes or tubercles 17
14 Aedeagus with flagellum of internal sac sinuate, not forming circles 15
- Aedeagus with flagellum of internal sac forming complete circle 16
15 Elytra with distinct parasutural striae. Metepisterna very narrow. Flagellum lacking basal hook . . . . *S. werneri* sp. n.
- Elytra without or with hardly visible parasutural striae. Metepisterna fairly wide. Flagellum with basal hook . . . . *S. hamata* sp. n.
16 Aedeagus with flagellum of internal sac evenly narrow, except at abruptly widened base. Parameres shorter than basal bulb of median lobe . . . . *S. bulbosa* sp. n.
- Aedeagus with flagellum of internal sac gradually narrowed apically, without abruptly widened base. Parameres longer than basal bulb of median lobe . . . . *S. sabapensis* Löbl
17 Aedeagus with ventral processes of median lobe approximate. Parameres not widened apically . . . . *S. orousseti* sp. n.

- Aedeagus with ventral processes of median lobe distant. Parameres widened apically 18
18 Aedeagus with flagellum of internal sac strongly sinuate, weakly widened basally, without basal hook . . . . *S. pseudotenella* sp. n.
- Aedeagus with flagellum of internal sac weakly sinuate, strongly widened basally, with basal hook . . . . *S. data* sp. n.

Scaphobaeocera bulbosa sp. n. Figs 1, 2

HOLOTYPE: ♂, Luzon, Lagunas Prov., Mt. Makiling, 400m, summit road, 19.XI.1995, I. Löbl (MHNG).

PARATYPES: 1 ♀ with the same data as the holotype; Lagunas Prov., Mt. Makiling, summit rd., 600m, 21.XI.95, I. Löbl. – 1 ♀, Lagunas Prov., Mt. Makiling, summit rd., 600m, 21-22.XI.1995, I. Löbl. – 1 ♂, Lagunas Prov., Mt. Makiling, above Mad Springs, 400-700m, 19-22.XI.1995, J. Kodada leg. – 1 ♂, Lagunas Prov., Mt. Banahaw ca 1 km Kinabuhayan, 500m, 26.XI.1995, I. Löbl leg (all MHNG).

DESCRIPTION: Length 1.05-1.25 mm, width 0.57-0.70 mm, dorsoventral diameter 0.59-0.72 mm. Head and body very dark, almost blackish, femora rufous, apical abdominal segments and remainder of appendages lighter, ochraceous. Thorax and elytra microsculptured, elytra very weakly iridescent. Pronotal and elytral punctation very fine, distinct at magnification 50x, punctation becoming somewhat coarser toward elytral apices. Length ratio of antennomeres as: III 5: IV 8: V 10: VI 9: VII 10: VIII 9: IX 12: X 12: XI 15. Segments III to VI equally narrow, segment III about twice as long as wide, segment V about 4 times as long as wide. Segments VII to IX each about 3 times as long as wide, segment VIII wider than segment VI. Segment XI almost 3 times as long as wide. Tip of scutellum exposed. Elytra with parasutural striae hardly visible, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron lacking longitudinal stria, with striate microsculpture. Middle part of metaventrite flat, with small, shallow impression in middle, densely and finely punctate, and short pubescence. Sides of metaventrite sparsely, extremely finely punctate, with long pubescence. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.03-0.05 mm long. Metepisterna flat, exposed portion about 0.06 mm wide, parallel-sided, with straight suture. Abdomen with fairly distinct striate microsculpture, very finely punctate. Basal punctures of ventrite 1 very fine. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 slightly widened, much narrower than protibiae. Aedeagus (Figs 1, 2) 0.28-0.31 mm long.

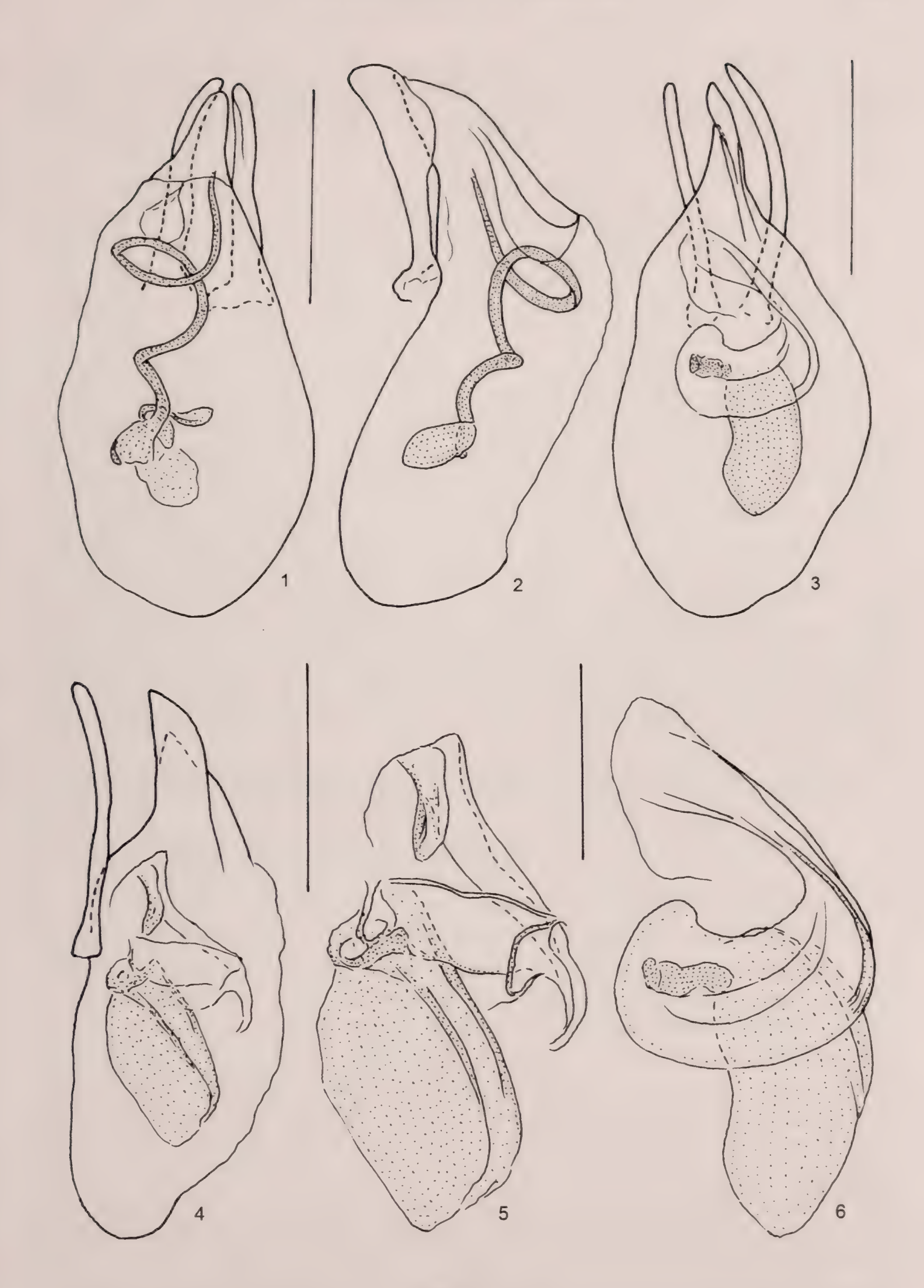
HABITAT: Degraded evergreen rain forest, in leaf litter and samples of moss and epiphytes on logs, under bark.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: This species is in external characters very similar to *S. sabapensis* Löbl, 1990. It may be distinguished from the latter by the aedeagus with shorter and thicker apical part of the median lobe, shorter parameres, and distinctive shape of the flagellum.

Scaphobaeocera complicans sp. n. Figs 3-6

HOLOTYPE: ♂, Luzon, Lagunas Pref., Mt. Makiling, summit rd., ca 600m, 26.XI.1995, I. Löbl (MHNG).



FIGS 1-6

(1, 2) *Scaphobaeocera bulbosa* sp. n., aedeagus in dorsal and lateral views; scale bar = 0.1 mm. (3-6) *Scaphobaeocera complicans* sp. n., aedeagus (3, 4) and internal sac (5, 6) in dorsal and lateral views. Scale bars = 0.2 mm for aedeagus, = 0.1 mm for internal sac.

PARATYPES: 7 ♂, 13 ♀, with the same data as the holotype. – 1 ♂, Philippines,Mt. Makiling, Lagunas Prov. 4 km SE Los Banos, 12-IV-1977 / berlese rotten logs L. E. Watrous. – 1 ♂ with the same data but 9-IV-1977 and berlese rotten figs (all MHNG).

DESCRIPTION: Length 1.05-1.20 mm, width 0.57-0.68 mm, dorsoventral diameter 0.65-0.75 mm. Body rufous, apical abdominal segments and appendages light ochraceus to yellowish. Thorax, elytra and abdominal ventrite 1 not microsculptured and not iridescent. Pronotal and elytral punctation very fine, that on elytra slightly coarser than on pronotum. Length ratio of antennomeres as: III 4: IV 8: V 9: VI 7: VII 10: VIII 6: IX 9: X 10: XI 26. Segment III short and narrow, about twice long as wide. Segments IV as narrow as segment III. Segments V and VI slightly wider than segment IV, segment V about 3 to 4 times as long as wide. Segment VII about 2.5 times as long as wide. Segment VIII twice as long as large. Segments IX and X slightly wider than segment VII. Segment XI conspicuously long, about 5 times as long as wide. Tip of scutellum exposed. Elytra with very fine parasutural striae, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron with stria. Middle part of metaventrite hardly convex, lacking stria or impression, with dense and fairly fine punctation except on narrow anterior area, and with fairly long pubescence. Sides of metaventrite sparsely and finely punctate, with long pubescence. Mesocoxal lines with fine marginal punctures, not extending laterally along mesepimera; submesocoxal areas about 0.03 mm long. Metepisterna flat, with exposed portion about 0.06-0.08 mm wide, parallel-sided, with straight suture. Abdominal ventrite 1 very finely punctate, with basal punctures fine, partly somewhat elongate. Following sternites with punctulate microsculpture. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 moderately widened, narrower than protibiae. Aedeagus (Figs 3-6) 0.44-0.53 mm long.

HABITAT: Evergreen rain forest, fungi on large log, in rotten log and on rotten figs.

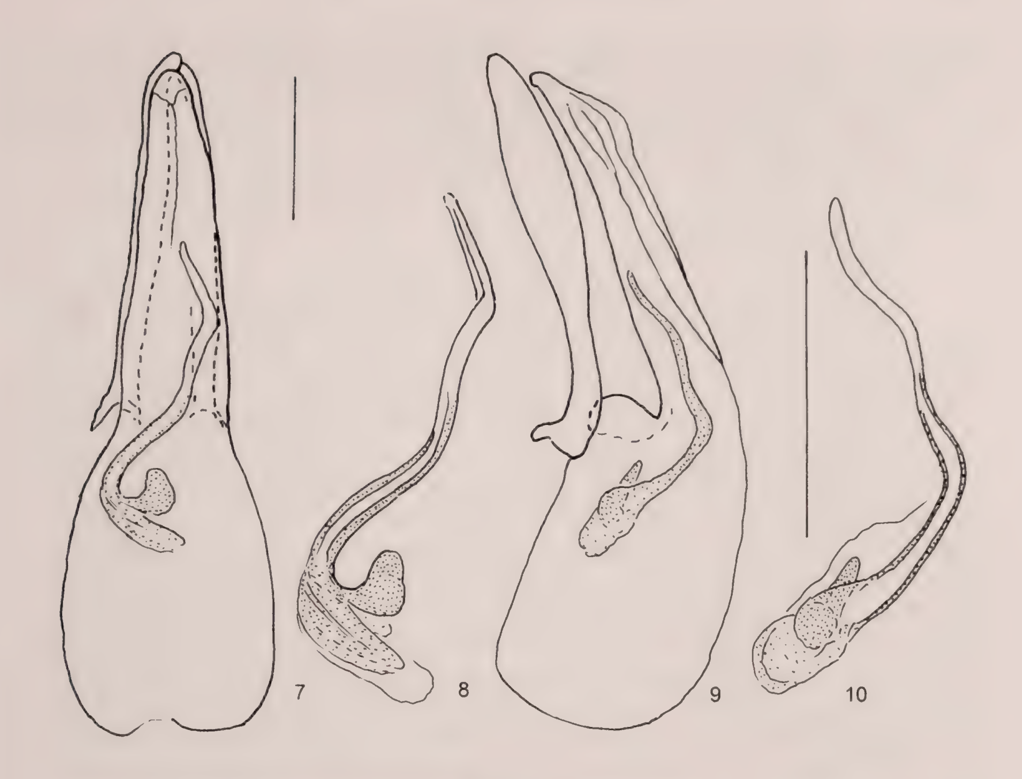
DISTRIBUTION: Philippines: Luzon.

COMMENTS: Several members of *Scaphobaeocera* have conspicuously long apical antennomere, compared to the antennomeres VII and X (*S. abnormalis* Löbl, 1981, *S. antennalis* Löbl, 1975, *S. cyrta* Löbl, 1980, *S. delicatula* Löbl, 1971, *S. dispar* Löbl, 1980, *S. dorsalis* Löbl, 1980, *S. japonica* (Reitter, 1880), *S. minutissima* (Löbl, 1969), *S. ponapensis* Löbl, 1981, *S. remota* Löbl, 1981, and *S. stephensoni* Löbl, 1988). *Scaphobaeocera complicans* may be easily distinguished from those species by the shape of the internal sac of the aedeagus, in particular by its strongly expanded apical part and the bulbous basal part.

Scaphobaeocera data sp. n. Figs 7-10

HOLOTYPE: ♂, Luzon Mount Data Lodge 2200-2300m 22-23.XII.1979, L. Deharveng & J. Orousset #100 (MHNG).

PARATYPES: 26 ♂, 15 ♀, with the same data as the holotype; 2 ♂, with the same data but #86. – 1 ♀, 1 ♀, with the same data but #162; Mount Data, 9.I.80, J. Orousset #165. – 3 ♂, 5 ♀, Luzon, Mt. Data (2250m) Mountain Prov., 13., 14., 25. and 26. VII.1985, M. Sakai leg. – 2 ♂, Luzon Mt. Fangao, (2350m) Mountain Prov., 14.VII.1985, M. Sakai leg. – 2 ♂, 14 ♀, Pacay (2400m) nr. Sayangan Benguet Prov., 11. VII.1985, M. Sakai leg. (all MHNG).



FIGS 7-10

(7-10) *Scaphobaeocera data* sp. n., aedeagus (7, 9) and internal sac (8, 10) in dorsal and lateral views.

DESCRIPTION: Length 1.15-1.30 mm, width 0.65-0.73 mm, dorsoventral diameter 0.70-0.78 mm. Body very dark reddish-brown to almost black, apices of elytra usually lighter, apical abdominal segments and appendages ochraceous. Thorax, elytra and abdomen microsculptured and iridescent. Pronotal and elytral punctation very fine, hardly visible at magnification 100x. Length ratio of antennomeres as: III 6: IV 8: V 10: VI 8: VII 10: VIII 7: IX 10: X 10: XI 16. Segments III and IV equally narrow, segment III about 3 times as long as wide. Segments V and VI wider than segment IV, each about 3 times as long as wide. Segment VII almost 3 times as long as wide. Segment VIII slightly narrower than segment VII, about twice as long as wide. Segments IX and X distinctly wider than segment VII, each about twice as long as wide. Segment XI about 2.5 times as long as wide. Scutellum entirely concealed. Elytra with very fine parasutural striae, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron without stria. Middle part of metaventrite flat, with shallow stria, very dense and fine punctation, and very short pubescence. Sides of metaventrite sparsely and very finely punctate, with long pubescence. Mesocoxal lines with fine marginal punctures, not extending laterally along mesepimera; submesocoxal areas about 0.02-0.03 mm long. Metepisterna flat, with exposed portion about 0.04-0.06 mm wide, parallel-sided, with straight suture.

Abdomen with distinct microsculpture consisting of transverse striae. Abdominal ventrite 1 very finely punctate, with basal punctures fine, not elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 distinctly widened, narrower than protibiae. Aedeagus (Figs 7-10) 0.36-0.40 mm long.

HABITAT: Mountain broad-leaf forest, under bark, in rotten wood and floor litter.

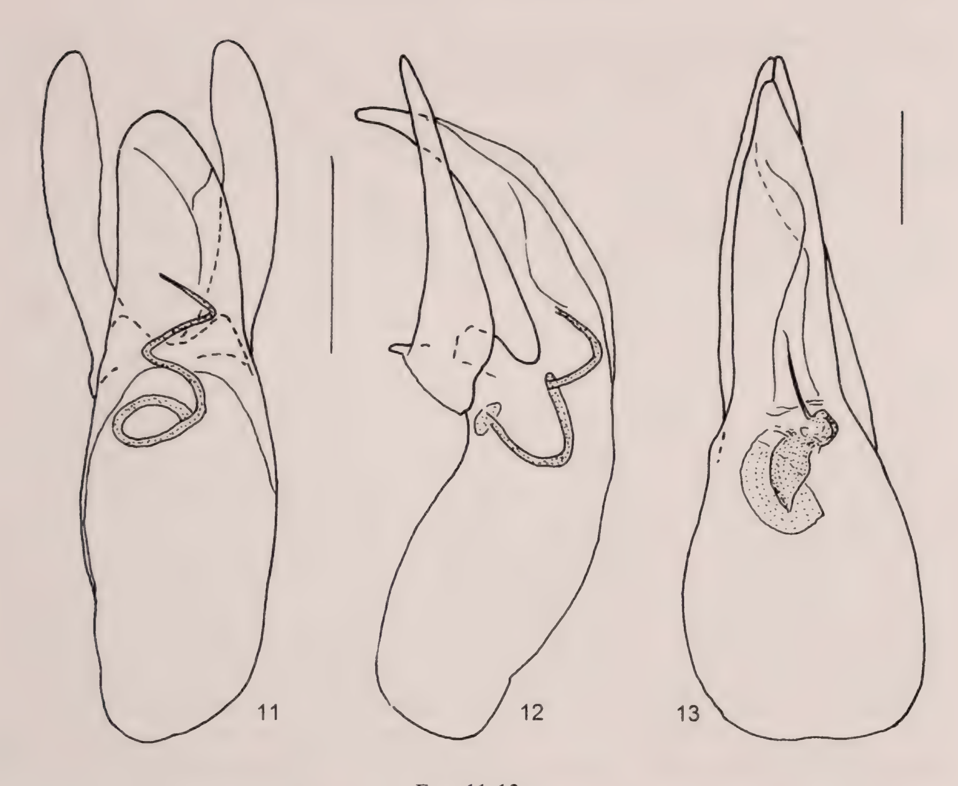
DISTRIBUTION: Philippines: Luzon.

COMMENTS: As in *S. data*, the Asian *S. cyrta* Löbl, 1980, *S. discreta* Löbl, 1980 and *S. smetanai* Löbl, 1981 possess flagellar basal hook and the median lobe of the aedeagus is lacking ventral processes. The new species may be distinguished from them by the convex apicoventral side of the basal bulb. Besides, *S. smetanai* may be separated by the robust basal part of the internal sac, *S. discreta* by the parameres gradually widened apically (in lateral view) and *S. cyrta* by the median lobe conspicuously arcuate, with tip reaching beyond parameres. The Papuan and Australian *S. papuana* Csiki, 1909, *S. ornata* (Pic, 1956), *S. piceoapicalis* Löbl, 1977 and *S. queenslandica* Löbl, 1986 have also aedeagi comparatively similar to that in *S. data*. The first three of them may be readily distinguished by their distinctive body coloration, *S. queenslandica* differs drastically by the shape of the parameres. Other Asian species that possess an internal sac with a basal hook are those originally described as *Baeotoxidium* Löbl, 1971, and since transferred to *Scaphobaeocera*: *S. elegans* (Löbl, 1971), *S. gagata* (Löbl, 1971), *S. indica* (Löbl, 1979), *S. lanka* (Löbl, 1971), *S. siamensis* (Löbl, 1990), and *S. yeti* (Löbl, 1992). These species are linked by the internal sac of the aedeagus with a basal vesicle containing spine-like structures, and probably form a monophyletic group.

Scaphobaeocea davaoana sp. n. Figs 11, 12

HOLOTYPE: ♂, E. slope Mt. McKinley, Davao Prov., MINDANAO IX.1946 / Elevation 6400 ft. / CNHM - Philippines Zool. Exped. (1946-47) F. G. Werner leg. (FMNH).

DESCRIPTION: Length 1.15 mm, width 0.62 mm, dorsoventral diameter 0.55 mm. Head and body uniformly ochraceous, appendages lighter. Thorax and elytra lacking microsculpture, not iridescent. Pronotal and elytral punctation extremely fine, barely visible at magnification 160x. Length ratio of antennomeres as: III 6: IV 7: V 8: VI 7: VII 11: VIII 5: IX 10: X 10: XI 14. Segment III comparatively short, about 3 times as long as wide. Segments IV to VI narrow, as wide as segment III. Segment VII almost 3 times as long as wide. Segment V-III slightly wider than segment VI, almost twice as long as wide. Segments IX and X distinctly larger than segment VII. Segment XI not widened apically, about 2.5 times as long as wide. Tip of scutellum exposed. Elytra without parasutural striae, sutural striae starting at margin of pronotal lobe, hardly curved at base. Hypomeron lacking longitudinal stria. Middle part of metaventrite flat, lacking stria or impression, coarsely and densely punctate, with long pubescence. Sides of metaventrite lacking microsculpture, sparsely, extremely finely punctate, with long pubescence. Mesocoxal lines with fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.03 mm long. Metepisterna flat, exposed portion about 0.05 mm wide, almost parallel-sided, with straight suture. Abdomen with striate microsculpture. Tibiae straight.



FIGS 11-13

(11, 12) *Scaphobaeocera davaoana* sp. n., aedeagus in dorsal and lateral views. (13) *Scapho - baeocera episternalis* sp. n., aedeagus in dorsal view. Scale bars = 0. 1 mm.

Male characters. Protarsi with segments 1 to 3 strongly widened, about as wide as protibiae. Aedeagus (Figs 11, 12) 0.37 mm long.

DISTRIBUTION: Philippines: Mindanao.

COMMENTS: The species resembles *S. nuda* Löbl, 1979 in external characters. Both possess not microsculptured thorax and elytra, very fine punctation, fairly similar antennae, and large exposed portion of metepisterna. *Scaphobaeocera davaoana* differs from *S. nuda* by the elytra not darkened at apex and lacking parasutural striae, and, more drastically, by its aedeagal characters. The new species may be distinguished from its congeners by following characters in combination: median lobe with robust, strongly prominent ventral processes, flagellum very narrow, and parameres wide in dorsal view, tapering in lateral view. The shape of the median lobe is similar to that in *S. uncata* Löbl, 1990, while the apically widened parameres differ conspicuously. Similar ventral processes are present in *B. amicalis* Löbl, 2003, *B. stipes* Löbl, 1971, *B. tenella* Löbl, 1990 and *B. uncata* Löbl, 1990. *Scaphobaeocera amicalis* and *B. uncata* differ conspicuously by the distal part of the median lobe strongly arcuate and reaching beyond tip of the parameres, *B. stipes* and *B. tenella* have the parameres widened in apical half and distinctive internal sac.

Scaphobaeocera episternalis sp. n. Figs 13-16

HOLOTYPE: ♂, Mindanao, Davao Prov., 25 km W of New Batan 20-22 May 1996, Bolm leg. (SMNS).

PARATYPES: 1 ♂, with the sama data as the holotype (MHNG). – 1 ♀, Mindanao, 30 km NW of Maramag, 13-17 May 1996 Bagongsilang, 1700m, Bolm leg. (SMNS).

DESCRIPTION: Length 1.23-1.26 mm, width 0.72-0.75 mm, dorsoventral diameter 0.72-0.75 mm. Head, most of body, femora and tibiae light rufous, apices of elytra, apex of abdomen and legs lighter, ochraceous, tarsi and antennomeres I to V or VI yellowish, antennomers VII to XI brown. Pronotum lacking microsculpture. Elytra microsculptured and weakly iridescent. Pronotal and elytral punctation sparse and extremely fine, hardly visible at magnification 100x. Length ratio of antennomeres as: III 8: IV 8: V 9: VI 8: VII 11: VIII 8: IX 12: X 12: XI 20. Segments III and IV equal, each about 3 times as long as wide. Segments V and VI slightly wider than segment IV, segment V 3 times as long as wide. Segment VII almost 3 times as long as wide. Segment VIII slightly wider than segment VI, about 2.5 times as long as wide. Segments IX and X each distinctly wider than segment VIII. Segment XI parallel-sided, distinctly wider than segment X, somewhat more than 3 times as long as wide. Tip of scutellum exposed. Elytra with parasutural striae, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron lacking stria. Middle part of metaventrite convex, lacking stria or impression, smooth on large central part, with dense and fairly coarse punctation at each side of center and with fairly long pubescence. Sides of metaventrite sparsely and very finely punctate, with long pubescence. Mesocoxal lines with fairly coarse marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02 mm long. Metepisterna flat, with exposed portion about 0.10-0.14 mm wide, widest in anterior half, suture broadly arcuate toward anterior angles, slightly curved or oblique apically. Abdomen lacking obvious microsculpture and with punctation hardly visible. Abdominal ventrite 1 with basal punctures coarse, not elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, segment 1 slightly wider than protibia. Aedeagus (Figs 13-16) 0.57-0.58 mm long.

DISTRIBUTION: Philippines: Mindanao.

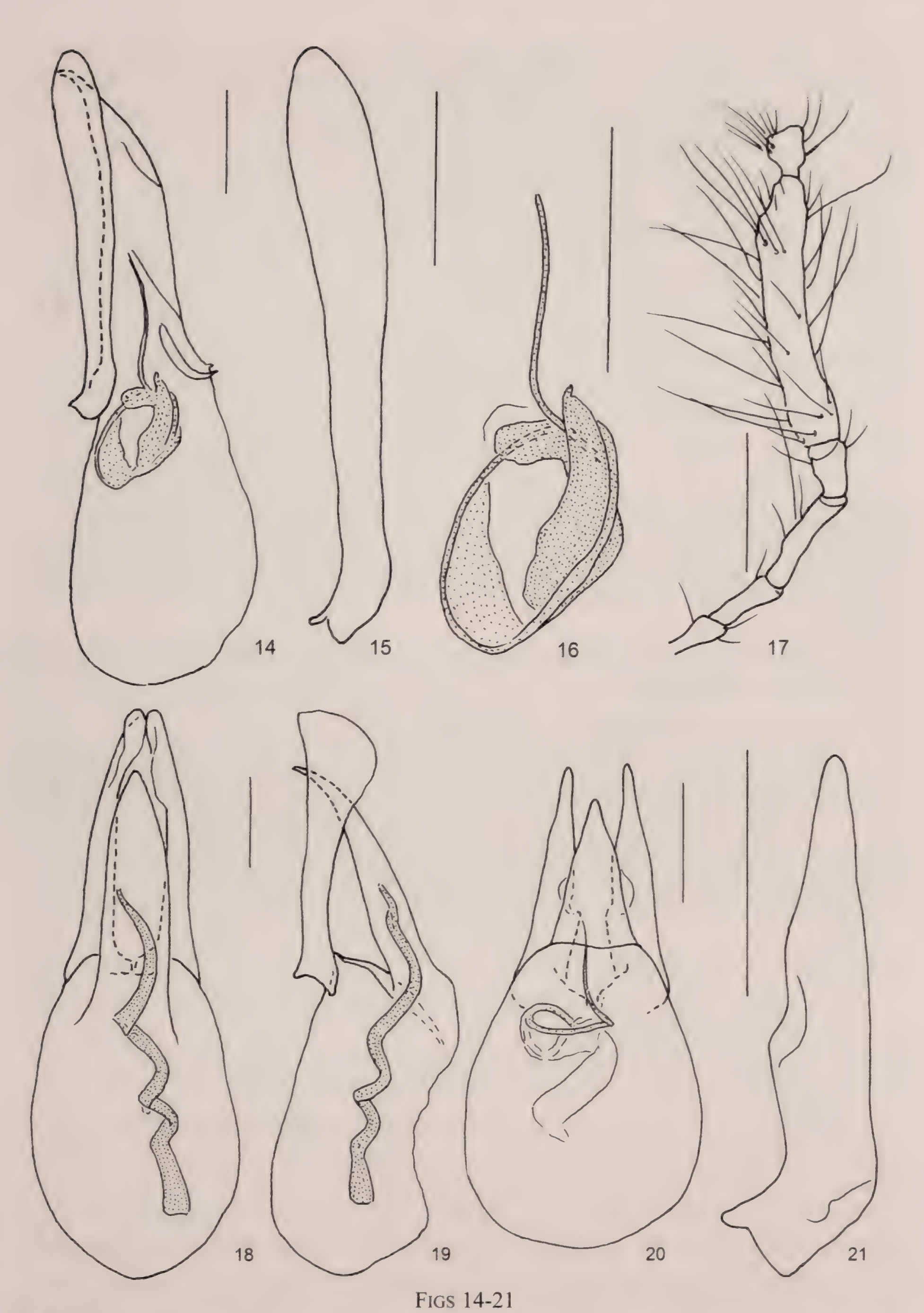
COMMENTS: This species may be readily distinguished from its Philippine congeners by its large metepisterna. It differs from most other species by the median lobe of the aedeagus that is not bent apically and has no distinct apicoventral processes. The internal sac with a complex base and very narrow flagellum reminds that in *S. tibialis* Löbl, 1984, while the parameres are wider and not arcuate as in the latter species.

Scaphobaeocea escensa sp. n. Figs 17-19

HOLOTYPE: ♂, Mindanao 30 km NW of Maramag, 13-17 May 1996, Bagongsilang, 1700m, Bolm leg. (SMNS).

PARATYPE: ♂, with same data as holotype (MHNG).

DESCRIPTION: Length 1.70 mm, width 1.0 mm, dorsoventral diameter 1.08 mm. Head and most of body uniformly very dark brown to blackish, abdomen and appen - dages reddish-brown. Pronotum lacking microsculpture, elytra with microsculpture



FIGS 14-21

(14-16) *Scaphobaeocera episternalis* sp. n., aedeagus in lateral view, paramere (15) and internal sac (16) enlarged. (17-19) *Scaphobaeocera escensa* sp. n., antennomeres III to VIII (17), aedeagus in dorsal and lateral views. (20, 21) *Scaphobaeocera excisa* sp. n., aedeagus in dorsal view (20), paramere in ventral view, enlarged. Scale bars = 0.1 mm.

hardly visible, not iridescent. Punctation extremely fine on pronotum, hypomera and lateral parts of metaventrite. Elytral punctation scattered, punctures much larger those on pronotum. Length ratio of antennomeres (Fig. 17) as: III 4: IV 8: V 12: VI 6: VII 30: VIII 5: IX 26: X 26: XI 26. Segment III comparatively short and wide, about 1.5 times as long as wide. Segment IV slightly narrower than segment III, about twice as long as wide. Segment V hardly wider than segment IV, 3 times as long as wide. Segment VI very short, gradually widened apically, wider than preceding segments, slightly longer than wide. Segment VII conspicuously long, more than 6 times as long as wide. Segment VIII very small, about as wide as segment VII and as wide as long. Segments IX and X similar to segment VII. Segment XI slightly widened apically. Tip of scutelum exposed. Elytra with sutural striae starting at pronotal lobe, parasutural striae present. Hypomeron not microsculptured, lacking longitudinal stria. Middle part of metaventrite flattened, with very short and shallow median stria, impunctate in center, distinctly punctate and with long pubescence laterally and behind center. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02 mm long. Metepisterna flat, about 0.05 mm wide, parallel-sided, with straight suture. Abdominal ventrite 1 with basal punctures fairly fine, partly elongate. Protibiae straight, meso and metatibiae weakly curved. Ventral side of profemora each with short, arcuate comb situated in level of trochanters.

Male characters. Protarsi with segment 1 to 3 strongly widened. Aedeagus (Figs 18, 19) 0.59-0.62 mm long.

DISTRIBUTION: Philippines: Mindanao.

COMMENTS: The very long antennomere VII, in combination with the small antennomere VIII, is diagnostic for this new species. *Scaphobaeocera zdenae* Löbl, 1992 has also strongly enlarged antennomere VII, but the antennomere VIII twice as long as wide. Besides, these two species may be easily distinguished by the pronotum and elytra distinctly microsculptured and iridescent in *B. zdenae* while they are not iridescent in *S. escensa*.

Scaphobaeocera excisa sp. n. Figs 20-23

HOLOTYPE: ♂, Luzon, Baguio, Mt. Santo Thomas, ca 1850m, 14.I.1980, L. Deharveng & J. Orousset leg. # 191 (MHNG).

PARATYPES: 3 ♂, with same data as the holotype; 2 ♂, Luzon, Baguio, Mt. Santo Thomas, ca 2150m, 14.I.1980, L. Deharveng & J..Orousset leg. #198 (all MHNG).

DESCRIPTION: Length 0.95-1.05 mm, width 0.60-0.63 mm, dorsoventral diameter 0.54-0.55 mm. Head and body ochraceous to blackish, appendages lighter. Thorax and elytra lacking microsculpture, not iridescent. Pronotal and elytral punctation very fine, dense, visible at magnification 32x. Length ratio of antennomeres as: III 6: IV 6: V 6: VI 6: VII 10: VIII 5: IX 9: X 9: XI 13. Segments III and IV similar, very narrow, each about 4 times as long as wide. Segments V and VI slightly wider than segment IV. Segment VII about 2.5 times as long as wide. Segment VIII about 1.3 times as long as wide. Segments IX and X hardly wider than segment VII. Segment XI not widened apically, almost 3 times as long as wide. Tip of scutellum exposed. Elytra without parasutural striae, sutural striae curved at base and extending along basal

margin to form short basal striae, ending in inner halves of basal elytral width. Hypomeron not microsculptured, lacking longitudinal stria. Middle part of metaventrite flat, lacking stria or impression, coarsely and densely punctate, with short pubescence. Sides of metaventrite lacking microsculpture, sparsely, extremely finely punctate, with long pubescence. Mesocoxal lines with coarse marginal punctures extending laterally along mesepimera; submesocoxal areas about 0.03 mm long. Metepisterna slightly convex, exposed portion about 0.05 mm wide, with arcuate suture. Abdomen with hardly visible punctulate microsculpture. Abdominal punctation fine, except comparatively distinct punctation on propygidium. Basal punctures of ventrite 1 partly elongate and coarse. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 slightly widened, much narrower than protibiae. Aedeagus (Figs 20-23) 0.35-0.38 mm long.

HABITAT: Moist ravine, in forest litter.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: The elytra with extended sutural striae and the shape of the parameres are diagnostic for this species. *Scaphobaeocera incisa* Löbl, 1990 has also emarginate parameres, but the emargination is subapical. Besides, it differs conspicuously in other aedeagal characters.

Scaphobaeocera hamata sp. n. Figs 24-26

HOLOTYPE: ♂, Philippines: Mt. Makiling, Laguna Prov., 4 km SE Los Banos 12-IV-1977 / berlese rotten logs L. E. Watrous (MHNG).

PARATYPES: 8 ♂, 3 ♀, with the same data as the holotype. – 3 ♂, 1 ♀, with the same data but 9-IV-1977. – 1 ♂, 1 ♀, with the same data but 8-IV-1977 / berlese leaf litter; 1 ♀, with the same data but 8-IV-1977 / berlese litter along stream. – 2 ♂, 1 ♀, with the same data but 11-IV-1977 / berlese debris under bark (all MHNG).

DESCRIPTION: Length 1.25-1.30 mm, width 0.66-0.70 mm, dorsoventral diameter 0.66-0.72 mm. Head and body ochraceous, appendages lighter, elytra sometimes slightly darkened near apex. Thorax and elytra microsculptured, elytra and often also pronotum weakly iridescent. Pronotal and elytral punctation very fine, dense, visible at magnification 32x. Length ratio of antennomeres as: III 5: IV 6: V 9: VI 8: VII 11: VIII 7: IX 11: X 10: XI 15. Segments III and IV similar, narrow, respectively 2.5 and 3 times as long as wide. Segments V and VI slightly wider than segment IV. Segment VII about 3 to 3.5 times as long as wide. Segment VIII about as wide as segment VII and almost twice as long as wide. Segments IX and X much wider than segment VII. Segment XI not widened apically, about 2.5 times as long as wide. Tip of scutellum exposed. Elytra without or with hardly visible parasutural striae, sutural striae starting at pronotal lobe. Hypomeron not microsculptured, lacking longitudinal stria. Middle part of metaventrite flat, with minute impression, densely punctate, pubescence short and very dense. Sides of metaventrite microsculptured, sparsely, extremely finely punctate, with fairly long pubescence. Mesocoxal lines with fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.01-0.02 mm long. Metepisterna slightly convex, exposed portion 0.05-0.06 mm wide, narrowed proximally, with straight suture. Abdomen with hardly visible striate microsculpture, punctation very fine. Basal punctures of ventrite 1 not elongate and fine. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, almost as wide as protibiae. Aedeagus (Figs 24-26) 0.32-0.42 mm long.

HABITAT: Evergreen rain forest, under bark, in rotten wood and leaf litter.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: The aedeagal characters suggest relationship to *S. data* and *S. monticola*. *Scaphobaeocera hamata* may be readily distinguished from the former by the lighter body color and from the latter by the sutural striae of the elytra reaching elytral base. See also comments under *S. data*.

Scaphobaeocera monticola sp. n. Figs 27-30

HOLOTYPE: ♂, Philippines: Luzon, Baguio, Mt. Santo Thomas, ca 2150m, 14.I.80, L. Deharveng & J. Orousset leg. # 198 (MHNG).

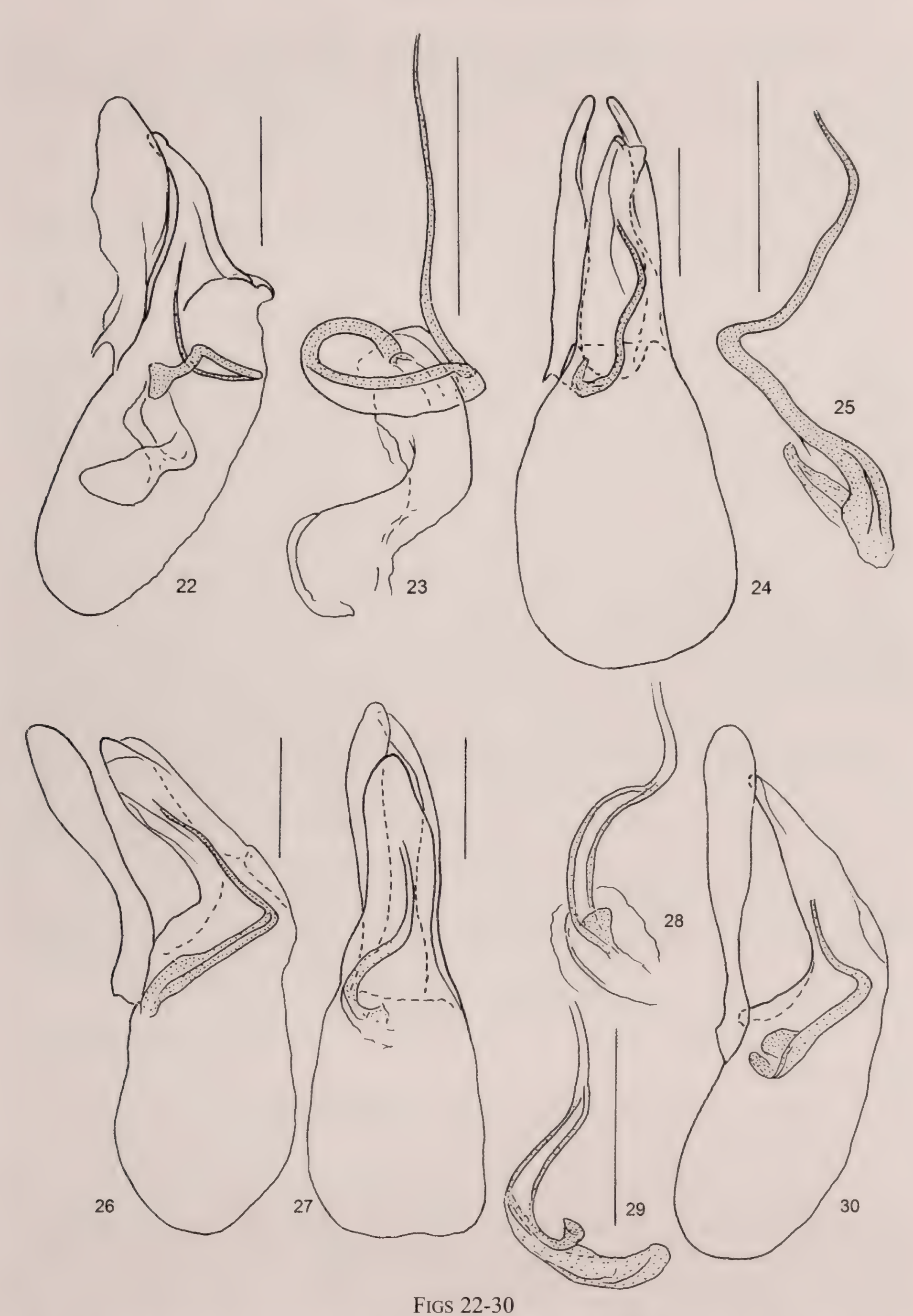
PARATYPES: 1 ♂, 1 ♀, with the same data as the holotype; 1 ♂, Luzon, Mountain Prov., Mount Data Lodge 2250-2300m, 23-24.XII.79, L. Deharveng & J. Orousset (MHNG).

DESCRIPTION: Length 1.20 mm, width 0.71-0.76 mm, dorsoventral diameter 0.71-0.75 mm. Body very dark reddish-brown to almost black, apices of elytra usually lighter, apical abdominal segments, legs and antennomeres I and II lighter, reddish-brown to ochraceous, antennomeres III to XI yellowish. Thorax, elytra and abdomen microsculptured and iridescent. Microsculpture on venter of thorax conspicuously coarse. Pronotal and elytral punctation very fine, hardly visible at magnification 100x. Length ratio of antennomeres as: III 5: IV 7: V 10: VI 8: VII 10: VIII 6: IX 10: X 10: XI 13. Segments III to VI evenly narrow, segment III about 2.5 times as long as wide, segments IV well 3 times as long as wide, V about 5 times as long as wide, VI about 4 times as long as wide. Segment VII about twice as wide as segment VI and almost 3 times as long as wide. Segment VIII slightly narrower than segment VII, about twice as long as wide. Segments IX and X wider than segment VII, each about 2.5 times as long as wide. Segment XI about 3 times as long as wide and as wide as segment X. Scutellum entirely concealed. Elytra with very fine parasutural striae, sutural striae starting posterior margin of pronotal lobe, not curved at base. Hypomeron without stria. Middle part of metaventrite flat, slightly impressed apically, without stria, with moderately dense, fine punctation and very short pubescence. Sides of metaventrite extremely finely punctate, with very short pubescence. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02-0.03 mm long. Metepisterna flat, with exposed portion about 0.04-0.05 mm wide, parallel-sided, with straight, deep suture. Abdomen with distinct microsculpture consisting of transverse striae. Abdominal ventrite 1 extremely finely punctate, with basal punctures fine, not elongate. Tibiae straight

Male characters. Protarsi with segments 1 to 3 distinctly widened, narrower than protibiae. Aedeagus (Figs 27-30) 0.39-0.41 mm long.

HABITAT: Mountain broad-leaf forest, in rotten wood and humus, in moss on log.

DISTRIBUTION: Philippines: Luzon.



FIGS 22-30

(22, 23) *Scaphobaeocera excisa* sp. n., aedeagus in lateral view (22), internal sac in dorsal view, enlarged (23). (24-26) *Scaphobaeocera hamata* sp. n., aedeagus in dorsal and lateral views, internal sac (26) enlarged. (27-30) *Scaphobaeocera monticola* sp. n., aedeagus in dorsal and lateral views, internal sac (29, 30) enlarged. Scale bars = 0.1 mm.

COMMENTS: This species is characterized by the elytra with shortened sutural striae. In addition, its comparatively coarse thoracic microsculpture is diagnostic. The aedeagus in *S. monticola* is similar to that in *S. data*, see also comments under the latter species.

Scaphobaeocera montivagans sp. n.

HOLOTYPE: ♂, Luzon: Philippines Mt. Pangao (2350m) nr. Data Ifugao Pv. 14.VII.1985, M. Sakai leg. (MHNG).

PARATYPE: ♂, Luzon: Mount Data 8.I.80, J. Orousset #165 (MHNG).

DESCRIPTION: Length 1.30-1.40 mm, width 0.76-0.82 mm, dorsoventral diameter 0.82-0.87 mm. Head and body dark reddish-brown, apical part of abdominal ventrite 1 and following ventrites lighter, reddish to ochraceous, appendages light reddish-brown to yellowish. Pronotum and hypomera lacking microsculpture, elytra, lateral parts of metaventrite, mesepimera, metepisterna and abdominal ventrites distinctly microsculptured. Elytra iridescent. Pronotal and elytral punctation very fine, hardly visible at magnification 100x. Length ratio of antennomeres as: III 5: IV 8: V 10: VI 7: VII 10: VIII 7: IX 11: X 10: XI 22. Segment III thickened apically, segments IV and V slightly narrower than segment III, IV about 4 times as long as wide, V about 5 times as long as wide. Segment VI distinctly wider than segment V, about twice as long as wide. Segment VII about twice as long as wide. Segment VIII slightly narrower than segment VII, almost twice as long as wide. Segments IX to XI about as wide as segment VII, IX and X each about twice as long as wide, XI about 4.5 times as long as wide. Tip of scutellum exposed. Hypomeron with stria. Elytra with very fine parasutural striae, sutural striae starting near base, slightly curved along pronotal lobe. Middle part of metaventrite somewhat convex, not impressed apically, without stria, with dense, fairly coarse punctation and rather long pubescence. Sides of metaventrite extremely finely punctate, with fairly long pubescence. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02-0.03 mm long. Metepisterna flat, with exposed portion about 0.08-0.09 mm wide, parallel-sided, with straight, deep suture. Abdomen with distinct microsculpture consisting of transverse striae. Abdominal ventrite 1 extremely finely punctate, with basal punctures fine, not elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 distinctly widened, narrower than protibiae.

HABITAT: Mountain broad-leaf forest, leaf and wood litter.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: This species resembles *S. complicans* from which it may be easily distinguished by the microsculpture pattern on the ventral side of body. The aedeagi of both males were lost. Nevertheless, the external characters of *S. montivagans* are unambiguously diagnostic.

Scaphobaeocera orousseti sp. n. Figs 31-34

HOLOTYPE: ♂, Luzon, Sagada s/résourgence d'Ambasing, 16.XII.79, L. Deharveng & J. Orousset #233 (MHNG).

PARATYPES: 1 ♂, Luzon, Mountain Prov. N. & NE Sagada, 15-19.XII.1979, L. Deharveng & J. Orousset #39. – 6 ♂, 2 ♀, Luzon, Mountain Prov. Sagada, Suyo: Tataya-An, 20.I.1980, L. Deharveng & J. Orousset # 201 (all MHNG).

DESCRIPTION: Length 1.18 mm, width 0.65 mm, dorsoventral diameter 0.68 mm. Body very dark reddish-brown, apices of elytra, apical abdominal segments and appendages light ochraceus to yellowish. Thorax, elytra and abdomen microsculptured, pronotal microsculpture barely visible. Pronotum not iridescent, elytra iridescent. Pronotal and elytral punctation very fine, distinct at magnification 50x. Length ratio of antennomeres as: III 6: IV 8: V 9: VI 8: VII 10: VIII 8: IX 10: X 10: XI 12. Segment III about 3 times as long as wide. Segment 4 about as narrow as segment III, segments V and VI slightly wider, each about 3 times as long as wide. Segment VII 3 times as long as wide. Segment VIII slightly wider than segment VI, about 3 times as long as wide. Segments IX to XI distinctly wider than segment VII, segment XI about 2.5 times as long as wide. Scutellum entirely concealed. Elytra with parasutural striae obsolete, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron without stria. Middle part of metaventrite flattened, with very shallow, minute impression in middle, dense and fairly fine punctation except on anterior area, and fairly long pubescence. Sides of metaventrite sparsely and very finely punctate, with long pubescence. Mesocoxal lines with fine marginal punctures, not extending laterally along mesepimera; submesocoxal areas about 0.03 mm long. Metepisterna somewhat convex, with exposed portion about 0.06 mm wide, parallel-sided, suture deep and straight. Abdominal ventrite 1 very finely punctate, with basal punctures fairly coarse and elongate.

Male characters. Protarsi with segments 1 to 3 moderately widened, narrower than protibiae. Aedeagus (Figs 31-34) 0.60 mm long.

HABITAT: Ravin, in leaf litter and humus.

DISTRIBUTION: Philippines: Luzon.

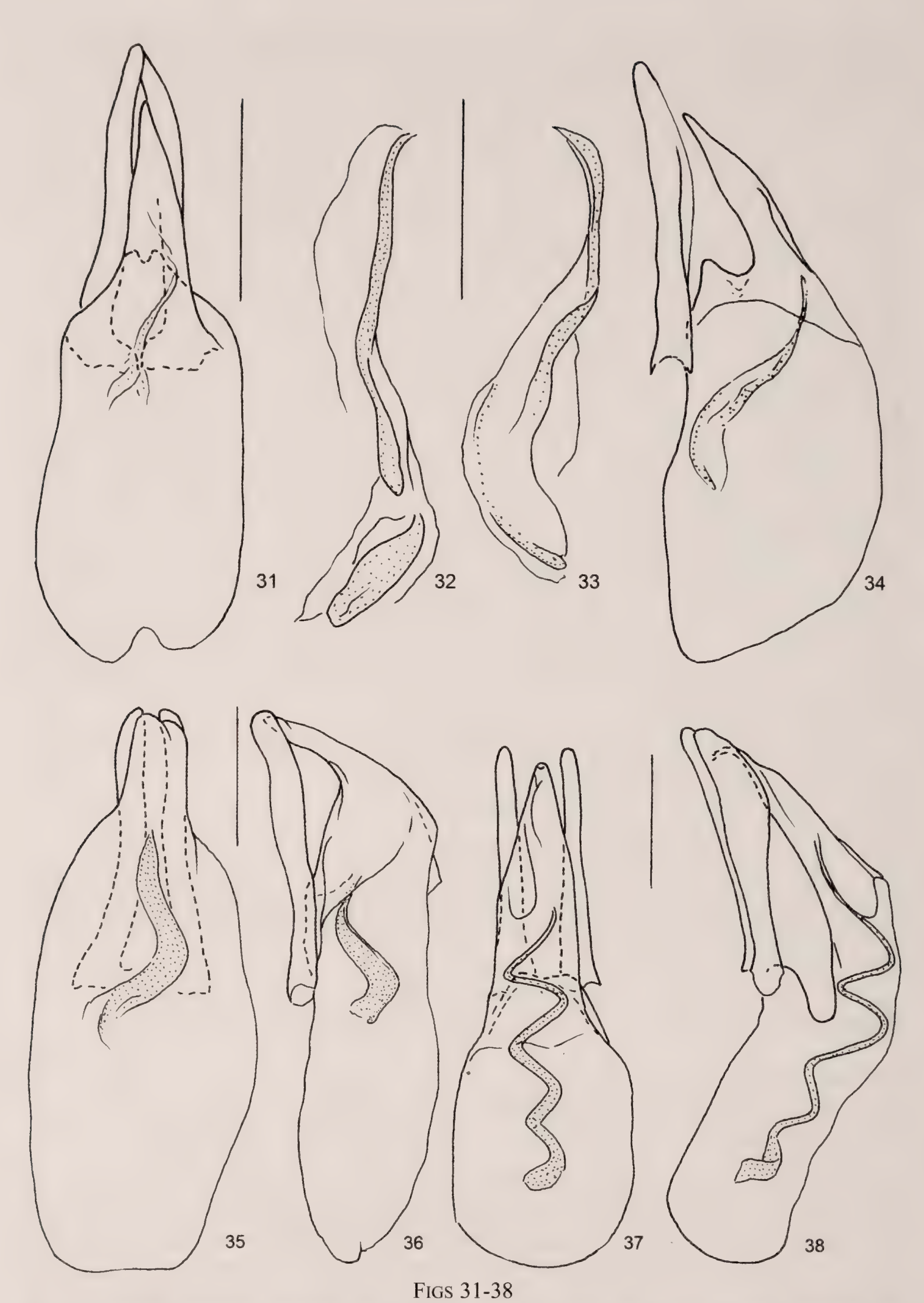
COMMENTS: This species is similar to *S. data* in external characters but may be distinguished by the elongate punctures at the base of the abdominal ventrite 1. See also comments under *S. davaoana*.

ETYMOLOGY: The species is named in honour of one of its collectors, Jean Orousset, Paris.

Scaphobaeocera palawana sp. n. Figs 35, 36

HOLOTYPE: ♂, Palawan, Central, Olangoan, 18 km NE San Rafael, sea level, I. Löbl, 5-6.XII.1995 (MHNG).

DESCRIPTION: Length 1.05 mm, width 0.60 mm, dorsoventral diameter 0.60 mm. Head and body very dark reddish-brown, apical abdominal segments and appendages lighter. Thorax and elytra lacking microsculpture, not iridescent. Pronotal and elytral punctation very fine, visible at magnification 100x. Length ratio of antennomeres as: III 5: IV 6: V 7: VI 6: VII 9: VIII 6: IX 9: X 10: XI 19. Segments III and IV equally narrow, segment IV 3 times as long as wide. Segments V and VI wider than segment IV, segment V about 3 times as long as wide. Segments VII and VIII each about twice as long as wide, segment VIII distinctly wider than segment VI. Segments



FIGS 31-38

(31-34) *Scaphobaeocera orousseti* sp. n., aedeagus in dorsal and lateral views, internal sac (32, 33) enlarged. (35, 36) *Scaphobaeocera palawana* sp. n., aedeagus in dorsal and lateral views. (37, 38) *Scaphobaeocera pseudotenella* sp. n., aedeagus in dorsal and lateral views. Scale bars = 0.1 mm for figs 31, 34-38, scale bar = 0.05 mm for figs 32, 33.

IX and X wider than segment VII, each almost twice as long as wide. Segment XI somewhat wider and almost 2 times as long as segment X, about 3 times as long as wide. Tip of scutellum exposed. Elytra without parasutural striae, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron lacking longitudinal stria. Middle part of metaventrite slightly convex, lacking stria or impression, center smooth, finely and densely punctate around center, and with short pubescence. Sides of metaventrite sparsely, extremely finely punctate. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02 mm long. Metepisterna flat, exposed portion about 0.06 mm wide, parallel-sided, with straight suture. Abdominal ventrite 1 lacking microsculpture, very finely punctate, with basal punctures hardly visible. Following ventrites with punctulate microsculpture. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 distinctly widened, narrower than protibiae. Aedeagus (Figs 35, 36) 0.38 mm long.

HABITAT: Edge of cultivated area, fungi on log.

DISTRIBUTION: Philippines: Palawan.

COMMENTS: The aedeagal characters of this species suggest relationship with *S. nuda* Löbl, 1979, although the apical part of the median lobe and the flagellum are notably shorter in the new species than in *S. nuda*. As *S. davaoana*, the new species lacks thoracic and elytral microsculpture and the hypomeral and parasutural striae, and has the exposed part of the metepisterna comparatively large. *Scaphobaeocera palawana* and *S. davaoana* may be readily distinguished by the length of the apical antennomere and the presence or absence of obvious abdominal microsculpture.

Scaphobaeocera pseudotenella sp. n. Figs 37, 38

HOLOTYPE: ♂, Luzon, Lagunas Prov., Mt. Makiling, 600m, summit rd, 21.XI.1995, leg. I. Löbl (MHNG).

PARATYPES: 1 ♀, with the same data as the holotype; 1 ♀, Luzon, Lagunas, Mt. Banahaw nr school about 1 km from Kinabuhayan, 500m, 26.XI.1995, leg. J. Kodada (both MHNG).

DESCRIPTION: Length 1.15-1.25 mm, width 0.70 mm, dorsoventral diameter 0.63-0.70 mm. Head and body uniformly reddish-brown, femora lighter, apical abdominal segments, tibiae, tarsi and antennae light brown or yellowish. Pronotum lacking microsculpture. Elytra, hypomera, lateral parts of metaventrite, mesepisterna, mesepimera and abdomen with distinct microsculpture. Elytra iridescent. Pronotal and elytral punctation very fine, barely visible at magnification 50x. Length ratio of antennomeres as: III 4: IV 6: V 8: VI 8: VII 13: VIII 7: IX 12: X 12: XI 15. Segment III short, about twice as long as wide. Segments IV to VI narrow, as wide as segment III, segment IV about 3 times as long as wide, segments V and VI each about 4 times as long as wide. Segment VII about 3 times as long as wide. Segment VIII about twice as long as wide. Segments IX to XI each slightly wider than segment VII, XI 3 times as long as wide. Scutellum entirely concealed. Elytra with parasutural striae, sutural striae starting at margin of pronotal lobe, hardly curved at base. Hypomeron lacking longitu-

dinal stria. Middle part of metaventrite flat, with median stria, distinctly, densely punctate, with short pubescence. Sides of metaventrite with fairly dense, fine punctation and fairly long pubescence. Mesocoxal lines with fine marginal punctures not extending laterally along mesepimera; submesocoxal areas about 0.02 mm long. Metepisterna flat, exposed portion about 0.03-0.04 mm wide, parallel-sided, with straight suture. Abdominal microsculpture distinct, ventrite 1 iridescent. Basal punctures of ventrite 1 not elongate. Tibiae straight in female.

Male characters. Protarsi with segments 1 to 3 distinctly widened, narrowed than protibiae. Protibiae straight, mesotibiae slightly curved, metatibiae somewhat sinuate. Aedeagus (Figs 37, 38) 0.42 mm long.

HABITAT: Degraded evergreen rain forest, leaf litter.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: This species shares most of the aedeagal characters with *S. tenella* Löbl, 1990. However, it differs from the latter species by the shape of the parameral apices which are clearly distinctive in lateral view. See also comments under *B. davaoana.*

Scaphobaeocera pubiventris sp. n. Figs 39, 40

HOLOTYPE: ♂, Luzon, Mountain Prov., N. & NE of Sagada 15-19.XII.1979, L. Deharveng & J. Orousset #46 (MHNG).

PARATYPES: 4 ♂, 6 ♀ with the same data as the holotype (MHNG).

DESCRIPTION: Length 1.25-1.40 mm, width 0.70-0.75 mm, dorsoventral diameter 0.71-0.81 mm. Head and most of body uniformly dark rufous to blackish, apex of abdomen and legs lighter, ochraceous, antennae conspicuously light, yellowish. Pronotum with microsculpture hardly visible, distinctly iridescent in darker specimens, not or barely iridescent in lighter specimens. Elytra microsculptured and iridescent. Pronotal and elytral punctation very fine, irregular, elytra usually with scattered punctures larger than those on pronotum. Length ratio of antennomeres as: III 5: IV 8: V 9: VI 7: VII 12: VIII 7: IX 12: X 12: XI 17. Segment III comparatively short and wide, about twice long as wide. Segments IV to VI about as wide as segment III, segment V 3 times as long as wide. Segment VII about twice as long as wide. Segment VIII about 1.5 times as long as wide. Segments IX and X hardly larger than segment VII. Segment XI not widened apically, about 3 times as long as wide. Tip of scutellum exposed. Elytra with distinct parasutural striae, sutural striae starting at margin of pronotal lobe, slightly curved at base. Hypomeron not microsculptured, with longitudinal stria. Middle part of metaventrite flat, lacking stria or impression. Sides of metaventrite microsculptured, sparsely and finely punctate, with long pubescence. Mesocoxal lines with very fine marginal punctures not extending laterally along mesepimera; sub-mesocoxal areas about 0.02 mm long. Metepisterna flat, with exposed portion about 0.04-0.05 mm wide, almost parallel-sided, with suture slightly curved apically. Abdomen with striate microsculpture, hardly visible on ventrite 1 in some specimens. Abdominal ventrite 1 with basal punctures fairly coarse, partly elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, about as wide as protibiae. Middle part of metaventrite, its anterior fourth excepted, completely covered by a very dense, flat patch of yellowish setae. Aedeagus (Figs 39, 40) 0.55-0.61 mm long.

Female characters. Metaventrite smooth in center, around center densely punctate, with short pubescence.

HABITAT: In rotten wood under a pine.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: This species has the median lobe of the aedeagus similar to that in *S. davaoana*, *S. amicalis* Löbl, 2003, *S. tenella* Löbl, 1990 and *S. uncata* Löbl, 1990. See also comments under *S. davaoana*. It differs drastically from these species by the much wider flagellum. The pubescence covering completely the middle part of the male metaventrite is diagnostic for this new species.

Scaphobaeocera sabapensis Löbl, 1990

MATERIAL EXAMINED: 3 ♂, 2 ♀, Luzon, Lagunas Prov., Mt. Makiling, 600m, summit rd, 21.XI.1995, leg. I. Löbl. – 1 ♀, same data but 20.XI, 450-500m. – 2 ♀, Luzon, Lagunas, Mt. Banahaw ca 1 km Kinabuhayan, 500m, 26.XI.1995, I. Löbl. – 1 ♀, Luzon, Lagunas, Mt. Banahaw above Kinabuhayan, 600-700m, trail to Crystalino 24.XI.1995, J. Kodada & B. Rygová leg. (all MHNG).

HABITAT: Evergreen rain forest, leaf litter.

DISTRIBUTION: Thailand, Philippines: Luzon.

COMMENTS: The aedeagi of the three Philippine males have the ventral wall of the apical process of the median lobe almost regularly arcuate and so slightly differ from those in the examined Thai specimens.

Scaphobaeocera serpentis sp. n. Figs 41-43

HOLOTYPE: ♂, Philippines: Mt. Makiling, Laguna Prov., 4 km SE Los Banos 9-IV-1977 / berlese leaf litter L. E. Watrous (MHNG).

PARATYPES: 1 ♂, 2 ♀ with the same data as holotype; 1 ♂, with the same data but 11-IV-1977 / berlese litter under bark L. E. Watrous (all MHNG).

DESCRIPTION: Length 0.95-1.05 mm, width 0.58-0.61 mm, dorsoventral diameter 0.53-0.58 mm. Head and most of body uniformly light ochraceous, appendages hardly lighter than body. Pronotum and elytra lacking microsculpture. Punctation extremely fine on pronotum, elytra, hypomera and lateral parts of metaventrite. Length ratio of antennomeres as: III 4: IV 6: V 7: VI 5: VII 11: VIII 4: IX 12: X. 12: XI 16. Segments III and IV evenly narrow, segment IV about twice as long as wide. Segment V slightly wider than segment IV, about 3 times as long as wide. Segment VI about twice as long as wide, wider than segment V. Segment VII much larger than segment VI, not quite 3 times as long as wide. Segment VIII conspicuously small, slightly longer than wide. Segments IX to XI almost even in width, hardly wider than segment VII, segment XI about 3 times as long as wide. Tip of scutellum exposed. Elytra without parasutural striae, sutural striae starting at margin of pronotal lobe, hardly curved at base. Hypomeron not microsculptured, without longitudinal stria.

Middle part of metaventrite slighly convex, without impression, densely punctate around smooth center, with fairly long pubescence. Mesocoxal lines with coarse marginal punctures, not extending laterally along mesepimera; submesocoxal areas about 0.03 mm long. Metepisterna flat, exposed portion about 0.08-0.10 mm wide, with suture notably deep, sulciform, weekly arcuate. Abdominal ventrite 1 very finely punctate, lacking obvious microsculpture, with basal punctures coarse, partly elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, about as wide as protibiae. Aedeagus (Figs 41-43) 0.25-0.27 mm long.

HABITAT: Evergreen rain forest, leaf litter.

DISTRIBUTION: Philippines: Luzon.

COMMENTS: This species shares with *S. episternalis* large metepisterna and mesocoxal lines with conspicuous, coarse marginal punctures. Both species may be distinguished by charaters given in the key above. In addition, the aedeagus is distinctive in *S. serpentis*.

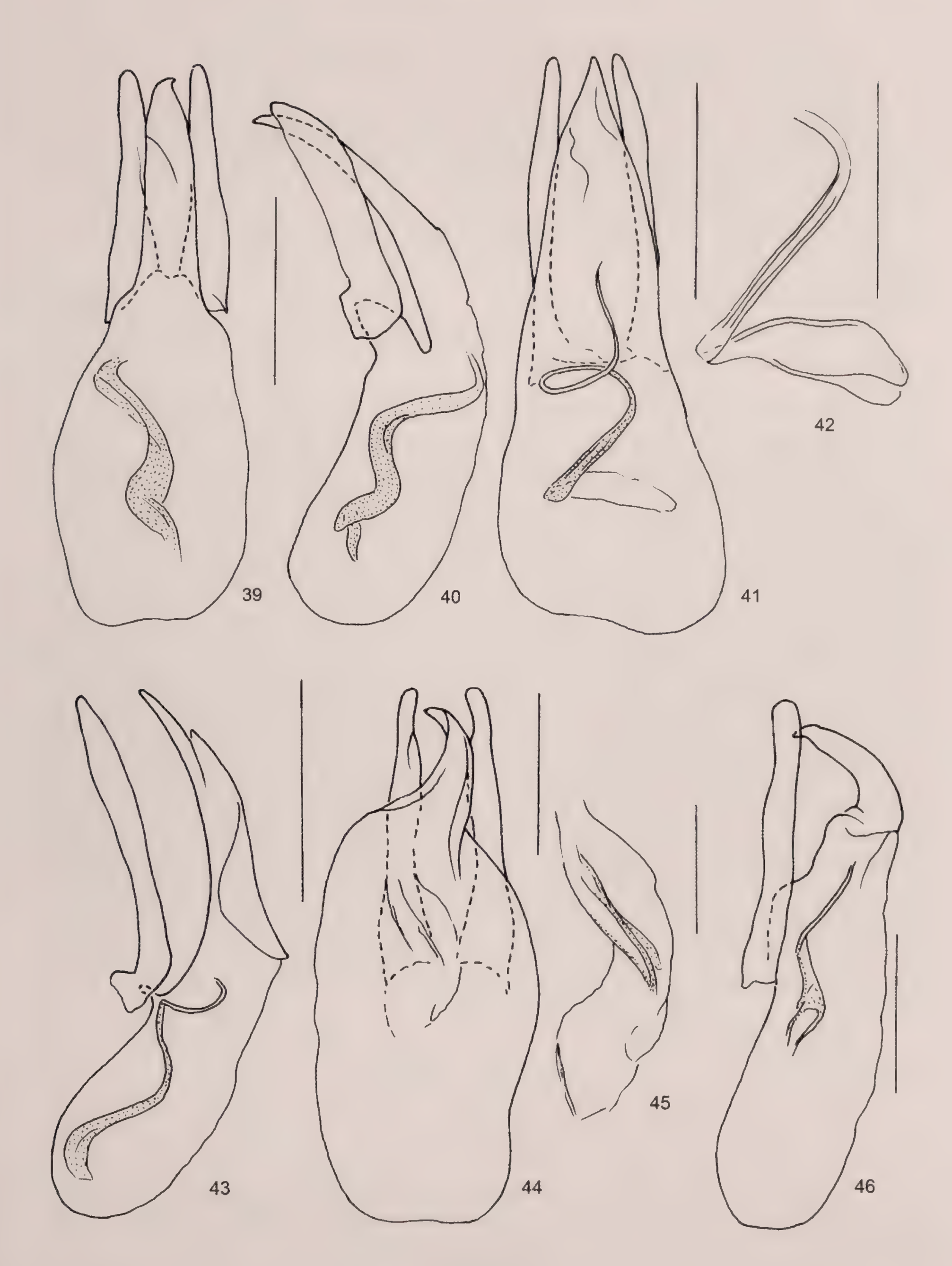
Scaphobaeocera watrousi sp. n. Figs 44-46

HOLOTYPE: ♂, Philippines: Mt. Makiling, Laguna Prov., 4 km SE Los Banos 11-IV-1977 / berlese debris under bark L. E. Watrous (MHNG).

PARATYPES: 1 ♀, with same data as holotype. – 1 ♂, Philippines: Mt. Makiling, Laguna Prov., 4 km SE Los Banos 8-IV-1977 / berlese debris rotten log L. E. Watrous and berlese rotten log. – 1 ♂, 4 ♀, with same data but berlese leaf litter (all MHNG); 1 ♂, Tarragona, Leyte Is., Philippine Islds. VIII: 11: 1945 coll. and pres. by C. L. Remington (FMNH).

DESCRIPTION: Length 1.0-1.10 mm, width 0.60-0.65 mm, dorsoventral diameter 0.63-0.67 mm. Head and most of body uniformly light ochreous, appendages lighter than body. Pronotum lacking microsculpture. Basal half of elytra not microsculptured, apical half of elytra microsculptured, hardly iridescent. Punctation extremely fine on pronotum, elytra, hypomera and lateral parts of metaventrite. Length ratio of antennomeres as: III 5: IV 6: V 8: VI 5: VII 9: VIII 6: IX 10: X 10 : XI 22. Segments III to IV equally narrow, segment IV about 2.5 to 3 times as long as wide. Segment V hardly wider than segment IV, about 4 times as long as wide. Segment VI about 2 to 3 times as long as wide, wider than segment V. Segment VII much wider than segment VI, about twice as long as wide. Segment VIII almost as wide as segment VII and not quite 2 times as long as wide. Segments IX to XI almost equally wide, not or slightly wider than segment VII, segment XI about 4 to 5 times as long as wide. Tip of scutellum exposed. Elytra without parasutural striae, sutural striae starting at margin of pronotal lobe, hardly curved at base. Hypomeron not microsculptured, with longitudinal stria. Middle part of metaventrite slighly convex, without impression, smooth in center, very densely punctate laterally and posterior center, with fairly long pubescence. Mesocoxal lines with marginal punctures fine, distinct, not extending laterally along mesepimera; submesocoxal areas about 0.02 mm long. Metepisterna flat, exposed portion about 0.07-0.09 mm wide, narrowed anteriad, with suture straight and deep. Abdomen with distinct striate microsculpture. Abdominal ventrite 1 very finely punctate, with basal punctures fairly coarse, elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, about as wide as protibiae. Aedeagus (Figs 44-46) 0.32-0.34 mm long.



FIGS 39-46

(39, 40) *Scaphobaeocera pubiventris* sp. n., aedeagus in dorsal and lateral views; scale bar = 0.2 mm. (41-43) *Scaphobaeocera serpentis* sp. n., aedeagus in dorsal and lateral views, internal sac (42) enlarged. Scale bar = 0.1 mm for figs 41, 43; scale bar = 0.05 mm for fig. 42. (44-46) *Scaphobaeocera watrousi* sp. n., aedeagus in dorsal and lateral views, internal sac (45) enlarged. Scale bar = 0.1mm for figs 44, 46; scale bar = 0.05 mm for fig. 45.

HABITAT: Evergreen rain forest, rotted wood and leaf litter.

DISTRIBUTION: Philippines: Luzon and Leyte.

COMMENTS: The aedeagus of this species is similar to that in *S. palawana*. This new species may be easily distinguished from the latter by the lighter coloration of the body and the presence of hypomeral striae.

ETYMOLOGY: The species is named in honour of one of its collectors, Larry E. Watrous, Ballwin, MO, USA.

Scaphobaeocera werneri sp. n. Figs 47-51

HOLOTYPE: ♂, E. slope Mt. McKinley, Davao Prov., MINDANAO Elev. 3200ft. Lot #54. IX, 7-8. 1946; beating / CNHM Philippine Zool. Exped. (1946-47) F. G. Werner leg. (FMNH).

PARATYPES: 3 ♂ and 2 ♀, with the same data as the holotype (FMNH, MHNG).

DESCRIPTION: Length 1.0-1.10 mm, width 0.55-0.62 mm, dorsoventral diameter 0.58-0.64 mm. Head and most of body uniformly very dark reddish-brown, apex of abdomen and appendages light, ochraceous. Pronotum lacking microsculpture, elytra microsculptured and distinctly iridescent. Punctation extremely fine on pronotum, hypomera, elytra and lateral parts of metaventrite. Length ratio of antennomeres (Fig. 47) as: III 5: IV 6: V 8: VI 7: VII 10: VIII 7: IX 11: X 10: XI 15. Segment III comparatively short, about 3 times as long as wide. Segments IV to VI narrow, as wide as segment III. Segment VII about 2.5 times as long as wide. Segment VIII wider than segment VI. Segments IX and X distinctly larger than segment VII. Segment XI not widened apically, about 3 times as long as wide. Tip of scutellum exposed. Elytra with distinct parasutural striae, sutural striae starting at margin of pronotal lobe, hardly curved at base. Hypomeron not microsculptured, lacking longitudinal stria. Middle part of metaventrite flat, with or without minute, shallow impression, very densely punctate, with short pubescence. Lateral parts of metaventrite sparsely punctate, with striate microsculpture hardly visible at 100x magnification, and fairly long pubescence. Mesocoxal lines with fine marginal punctures fine, not extending laterally along mesepimera; submesocoxal areas about 0.01 mm long. Metepisterna flat, exposed portion about 0.01-0.02 mm wide, almost parallel-sided, with suture slightly curved. Abdomen with distinct striate microsculpture. Abdominal ventrite 1 with basal punctures fairly fine, partly elongate. Tibiae straight.

Male characters. Protarsi with segments 1 to 3 strongly widened, about as wide as protibiae. Aedeagus (Figs 48-51) 0.29-0.32 mm long.

HABITAT: Found by beating vegetation.

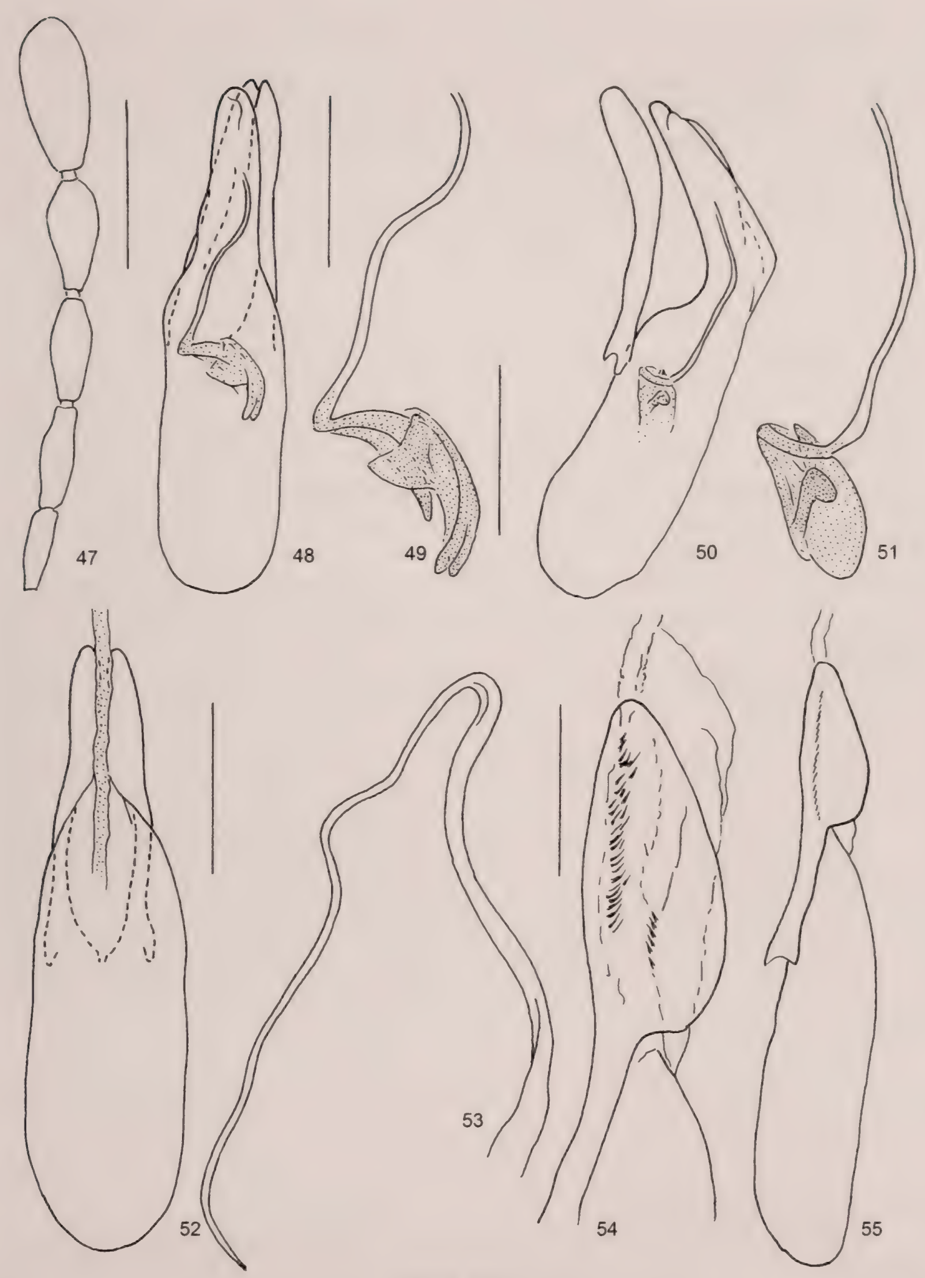
DISTRIBUTION: Philippines: Mindanao.

COMMENTS: The aedeagal characters suggest relationship with *S. hamata*, the shape of the base of the flagellum in these species is, however, clearly distinctive. This species may be distinguished from *S. hamata* also by its narrow metepisterna.

ETYMOLOGY: The species is named in honour of its collector, Floyd G. Werner.

Xotidium Löbl, 1992

The genus is distinctive by having two-segmented labial palpi. It comprises five species known at present only from Mauritius, Sri Lanka, Himalaya, and Queensland.



Figs 47-55

(47-51) *Scaphobaeocera werneri* sp. n., contours of antennomeres VII to XI (47); aedeagus in dorsal and lateral views, internal sac (49, 51) enlarged. Scale bars = 0.1 mm for figs 47, 48, 50; scale bar = 0.05 mm for figs 49, 51. (52-55) *Xotidium tubuliferum* sp. n., aedeagus in dorsal and lateral views (52, 55), apical, tubular part of internal sac (53), apical part of aedeagus with extruded basal portion of internal sac (54). Scale bars = 0.2 mm for figs 52, 55; scale bar 0.1 mm for figs 53, 54.

An additional species is present within the examined material from the Philippines and described below.

Xotidium tubuliferum sp. n. Figs 52-55

HOLOTYPE: ♂, Tarragona, Leyte I. Philippine Islds VIII: II: 1945 / Col. & pres. by C. L. Remington /in rotting burned log (FMNH).

ADDITIONAL MATERIAL: 1 ♂ (lacking head and prothorax), with the same data as the holotype (MHNG).

DESCRIPTION: Length 1.60 mm, width 0.98 mm, dorsoventral diameter 0.93 mm. Body and head uniformly reddish-brown to piceous, femora, tibiae and basal abdominal segments hardly lighter, apical abdominal segments, antennae and tibiae distinctly lighter, almost yellowish. Length ratio of antennomeres as: III 10: IV 14: V 16: VI 15: VII 18: VIII 18: IX 15: X 18: XI 22. Segments III to VIII very narrow, segments VII and VIII similar, only slightly wider than segment III to VI, segments IX to XI much wider. Pronotal and elytral punctation very fine, visible at 50x magnification. Lateral parts of metaventrite and abdomen impunctate. Elytra each with fine basal stria joined to sutural and lateral striae; adsutural areas flat. Center of metaventrite almost flat, with few distinct punctures. Mesocoxal areas 0.07 mm long, shortest interval to metacoxae about 0.10 mm. Metepisterna flat, parallel-sided, about 0.08 mm wide. Abdomen impunctate, with punctulate microsculpture, metacoxal lines impunctate.

Male. Segments 1-3 of protarsi slightly widened. Aedeagus (Figs 52-55) 0.72 mm long.

HABITAT: Rotting burned log.

DISTRIBUTION: Philippines: Leyte.

COMMENTS: This new species resembles *X. uniforme* Löbl, 1992 by its compa - ratively large size and by the color of the body, in combination with the elytra having complete and joined basal and sutural striae. *Xotidium mauritianum* (Vinson, 1943) is almost as large and has also unicolored body, but differs drastically from its congeners by the shortened sutural striae and the absence of basal striae (see VINSON, 1943). *Xotidium tubuliferum* may be distinguished easily by its aedeagus lacking sclerotized flagellum, and by the long widened apical section of the parameres.

Both available males have completely extruded internal sac of the aedeagus. It consists of a simple tube narrowed in middle, longer than the entire median lobe. Very fine, spine-like structures are present in its basal part.

ACKNOWLEDGEMENTS

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Taxonomic emendations in the genus *Liocheles* Sundevall, 1833 (Scorpiones, Liochelidae)

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Taxonomic emendations in the genus *Liocheles* Sundevall, 1833 (Scorpiones, Liochelidae). - Examination of an extensive material that includes the type series and recently collected specimens enable a precise reassessment of the status of several taxa belonging to the genus *Liocheles* Sundevall, 1833 (Scorpiones, Liochelidae). Two species previously in synonymy, i. e. *Liocheles boholiensis* (Kraepelin, 1914) and *Liocheles neocaledonicus* (Simon, 1877), are revalidated. *Liocheles australasiae longimanus* (Werner, 1939) is elevated to species rank and *Liocheles australasiae brevidigitatus* Werner, 1936 is synonymized with *Liocheles australasiae* (Fabricius, 1775). *L. boholiensis* (Kraepelin, 1914), *L. neocaledonicus* (Simon, 1877) and *L. longimanus* (Werner, 1939) are thoroughly redescribed, diagnosed and illustrated, and their distribution ranges are accurately mapped.

Keywords: *boholiensis* - *longimanus* - *neocaledonicus* - taxonomy - Australasia - Indonesia, Sumatra - New Caledonia - Philippines - Bohol.

INTRODUCTION

The genus *Liocheles* Sundevall, 1833 is currently divided into two species groups which are easily distinguishable by the trichobothrial pattern on the retrolateral side of the pedipalpal chela, i. e. the *Liocheles waigiensis* (Gervais, 1843) species group and the *Liocheles australasiae* (Fabricius, 1775) species group (Monod, 2000; Monod & Volschenk, 2004). Three species and two sub-species are recognised within the *australasiae*-group and six species within the *waigiensis*-group. However, an ongoing global taxonomic revision of the genus reveals an unsuspected specific diversity. Preliminary results of this work were first presented in an unpublished master thesis (Monod, 2000) carried out at the University of Geneva (Switzerland). The present contribution intends to formally present part of this work.

Over the years, several authors attempted to revise the genus but were unable to clearly assess the taxonomic status and position of most species, and several valid taxa are currently considered as junior synonyms owing to the paucity of diagnostic characters and to the scarcity of material available in museum collections, especially mature males that are essential for diagnoses of species. Examination of an extensive material, including types, and recent field surveys conducted by the author during which fresh specimens were collected, allowed a precise reassessment and subsequent

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reinstatement of two species in synonymy, i.e. *Liocheles boholiensis* Kraepelin, 1914, and *Liocheles neocaledonicus* Simon, 1877. Besides, *Liocheles australasiae longimanus* (Werner, 1939) is elevated to species rank, while *Liocheles australasiae brevidigitatus* Werner, 1936 is synonymized with *Liocheles australasiae australasiae* (Fabricius, 1775). Redescriptions, diagnoses, illustrations of important characters and distribution maps are provided for the three re-established taxa.

Liocheles boholiensis described by Kraepelin in 1914, was placed into the synonymy of *L. australasiae* by L. E. Koch (1977). However, the species clearly belongs to the *waigiensis* group. Unlike in most species of the *waigiensis* group, the anterior area of the carapace is almost completely smooth and devoid of a coarse granulation, resembling the carapace of the *australasiae* group. This feature probably led Koch to erroneously considered the species as a junior synonym of *L. australasiae*. *Liocheles neocaledonicus* was first described as *Ischnurus neocaledonicus* by Simon (1877). Kraepelin (1894) synonymized it with *Hormurus caudicula* L. Koch, 1867, but subsequently (Kraepelin, 1914) restored it as a valid species in the genus *Hormurus* Thorell, 1837. Kopstein (1921) accepted Kraepelin's decision to split *H. caudicula* into several distinct species, including *H. neocaledonicus*, and Giltay (1931) cited Kraepelin (1914) as the reference for taxonomic identification of *Hormurus* species, but contrary to Kopstein he considered the different species of the *waigiensis* group as subspecies of *H. caudicula*, listing *H. caudicula neocaledonicus* from central and southern New Caledonia and describing *Hormurus caudicula sarasini* from the north of the island. Following Karsch (1880) who first synonymized *Hormurus* with *Liocheles*, Takashima (1945) recognized *L. neocaledonicus* and *L. sarasini* as subspecies of *L. caudicula*. L. E. Koch (1977) subsequently treated *H. caudicula* and most of its subspecies (including *L. caudicula neocaledonicus* and *L. caudicula sarasini*) as junior synonyms of *Liocheles waigiensis*. The present work confirms that *L. neocaledonicus* is a valid species while *L. sarasini* is a junior synonym of the former.

Two subspecies of *L. australasiae*, i.e. *L. australasiae brevidigitatus* and *L. australasiae longimanus* were described by Werner in 1936 and 1939, respectively. These taxa remained widely unknown to subsequent authors before Fet (2000) reported them in the Catalog of the scorpions of the world. Significant morphological differences from *L. australasiae* warrant the elevation of *L. australasiae longimanus* to species level. However, *L. australasiae brevidigitatus* cannot be separated from *L. australasiae* based on morphology and that subspecies is thus abolished.

MATERIAL AND METHODS

Examination: Specimens were examined with a ZEISS Stemi SV8 stereomicroscope. Morphological examination is sometimes hampered by mud and soil aggregates adhering to the tegument of specimens and these can obscure fine details. Ultrasonic treatment (sonication) was used to render the specimens free of obstructing particles (Nowak *et al.*, 2008). The specimens were placed for 15 to 90 seconds in a digital ultrasonic cleaner filled with soapy water. This step was repeated until a satisfactory degree of cleanliness was achieved. For smaller and older specimens more numerous but shorter rounds of sonication were carried out in order to avoid damage. Following sonication, the specimens were rinsed thoroughly with distilled water.

DISSECTION: Mature male specimens were dissected using microsurgical scissors and forceps in order to study their hemispermatophores. Paraxial organ tissue was removed either manually with forceps or chemically with Proteinase K (Qiagen, Venlo, The Netherlands) diluted with water to 50%. Hemispermatophores were emerged in the solution and then placed in an oven at 45-50°C for 15 minutes to an hour depending on the size and sclerotization of the structure. Once the soft tissue of the paraxial organ was sufficiently digested, hemispermatophore were retrieved from the solution and thoroughly rinsed with water.

TERMINOLOGY follows Vachon (1956, 1963) for cheliceral dentition, Stahnke (1970), Stockwell (1989), Sissom (1990) and Hjelle (1990) for pedipalp segmentation, Prendini (2000) for pedipalp carinae patterns, Vachon (1974) for trichobothrial patterns, Couzjin (1976) for leg segmentation, Prendini (2000) for metasomal carinae, and Lamoral (1979) and Monod & Volschenk (2004) for hemispermatophore morphology. Measurements follow Stahnke (1970) and were recorded in mm using an occular micrometer or a digital caliper.

ILLUSTRATION: Drawings were produced using a camera lucida mounted on the stereomicroscope. The sketches were subsequently drawn with ink pens and scanned for further processing and editing. Photographs and illustrations were subsequently edited in Photoshop CS5 (Adobe Systems, San Jose, CA, USA) (background removal and contrast adjustment) and plates were prepared with Illustrator CS5 (Adobe Systems, San Jose, CA, USA). Colour drawings were produced as digital media based on scientific illustrations, photographs of live specimens served as reference to accurately represent the body colours of the animals.

MAPPING: Distribution maps were produced using ArcGIS version 9.3 (Environmental Systems Research Institute, Redlands, CA, USA), by superimposing point locality records on SRTM 90 m (3 arc-second) digital elevation data (Jarvis *et al.*, 2008) and SRTM 1 km (30 arc-second) global bathymetry dataset (Becker *et al.*, 2009). Geographical coordinates for records without GPS data were traced by reference to gazetteers, the GEOnet Names Server (http://earth-info.nga.mil/gns/html/index.html), or detailed route maps of various earlier expeditions.

MATERIAL LIST: Following Chapman & Grafton (2008), GPS coordinates that may be used by potential collectors seeking to conduct mass harvesting in order to supply the arachnid pet trade were purposely removed from the list of material. These data may be supplied to researchers upon request.

ACRONYMS: Depositories of material examined are abbreviated as follows: AMNH, American Museum of Natural History (New York, USA); BPBM, Bernice P. Bishop Museum, Honolulu (Hawaii, USA); CAS, Californian Academy of Sciences (San Fransisco, USA); LM, Lionel Monod personal collection, to be deposited in the collection of the MHNG; MHNG, Muséum d'histoire naturelle (Genève, Switzerland); MM, Manchester Museum, University of Manchester (Manchester, United Kingdom); MNHN, Muséum national d'Histoire naturelle (Paris, France); MRHN, Musée Royal d'Histoire Naturelle de Belgique (Bruxelles, Belgium); NHML, Natural History Museum (London, United Kingdom); NMB, Naturhistorisches Musem (Basel,

Switzerland); NNHM, National Natuurhistorisch Museum (Leiden, The Netherlands); QM, Queensland Museum (Brisbane, Australia); USNM, United States National Museum of Natural History, Smithsonian Institution (Washington, DC, USA); WAM, Western Australian Museum (Perth, Australia); ZMAK, Zoologisches Forschungsinstitut und Museum Alexander Koenig (Bonn, Germany); ZMH, Zoologisches Staatsinstitut, Zoologisches Museum Hamburg (Hamburg, Germany). Besides, the following abbreviations were used: DDEE, Direction du Dévelopement Economique et de l'Environnement, Province Nord, Koné, New Caledonia); DRN, Direction des Ressources Naturelles, Province Sud, Nouméa, New Caledonia; IAC, Institut Agronomique Néo-Calédonien, Pocqueureux, La Foa; MIS, misidentification.

RESULTS

Family **Liochelidae** Fet & Bechly, 2001

Genus ***Liocheles*** Sundevall, 1833

Liocheles australasiae (Fabricius, 1775)

Liocheles australasiae brevidigitatus Werner, 1936 syn. n.

Liocheles boholiensis (Kraepelin, 1914) Figs 1-2, Table 1

Hormurus boholiensis Kraepelin, 1914: 333; Weidner, 1959: 101.
Hormurus caudicula boholiensis: Giltay, 1931: 12, 13, 18, 19.
Liocheles caudicula boholiensis: Takashima, 1945: 96.
Liocheles australasiae: L. E. Koch, 1977: 161 (misidentification).
Liocheles boholiensis: Monod, 2000: 72-76, pls 22-24, map 8.

DISTRIBUTION RANGE: This species is known only from Bohol Island (Central Visayas), Philippines. However, it is most likely present on other nearby Philippine islands.

MATERIAL EXAMINED: ZMH, without registration number; 1 ♀ syntype (here designated lectotype), 1 subadult ♀ syntype (here designated paralectotype); Philippines, Bohol; X.1863.

DIAGNOSIS: *L. boholiensis* can be distinguished from *L. waigiensis* by the following characters:

(1) prolateral process of pedipalp patella forming 2 distinct spiniform processes (bifid), these sometimes fused but not forming a large median spine; (2) ventral intercarinal surface of pedipalp chela granular along prolateral and retrolateral edges only, smooth medially; (3) retrolateral ventral intercarinal surface of pedipalp femur smooth or nearly so; (4) ventral intercarinal surface of pedipalp femur with granulation absent or vestigial and limited to the retrolateral edge; (5) ventrosubmedian carinae of metasomal segment I with 1-3 pairs of well developed medial granules; ventrosubmedian carinae of metasomal segment II with 1 pair of well developed subposterior spiniform granules and 1-3 pairs of well developed medial spiniform granules.

DESCRIPTION OF ADULT FEMALE: *Coloration*: The poor state of preservation of the type specimens did not allowed to accurately describe the coloration of the animals.

Ornamentation of cuticle: Non-granular surfaces of mesosoma, metasoma, prosoma, legs and pedipalp finely punctated.

Chelicerae (Fig. 1C): Medial and basal teeth of fixed finger fused into a bicusp. Movable finger: dorsal margin with four teeth (one subdistal and one basal); distal dorsal tooth smaller than distal ventral tooth; ventral margin smooth.

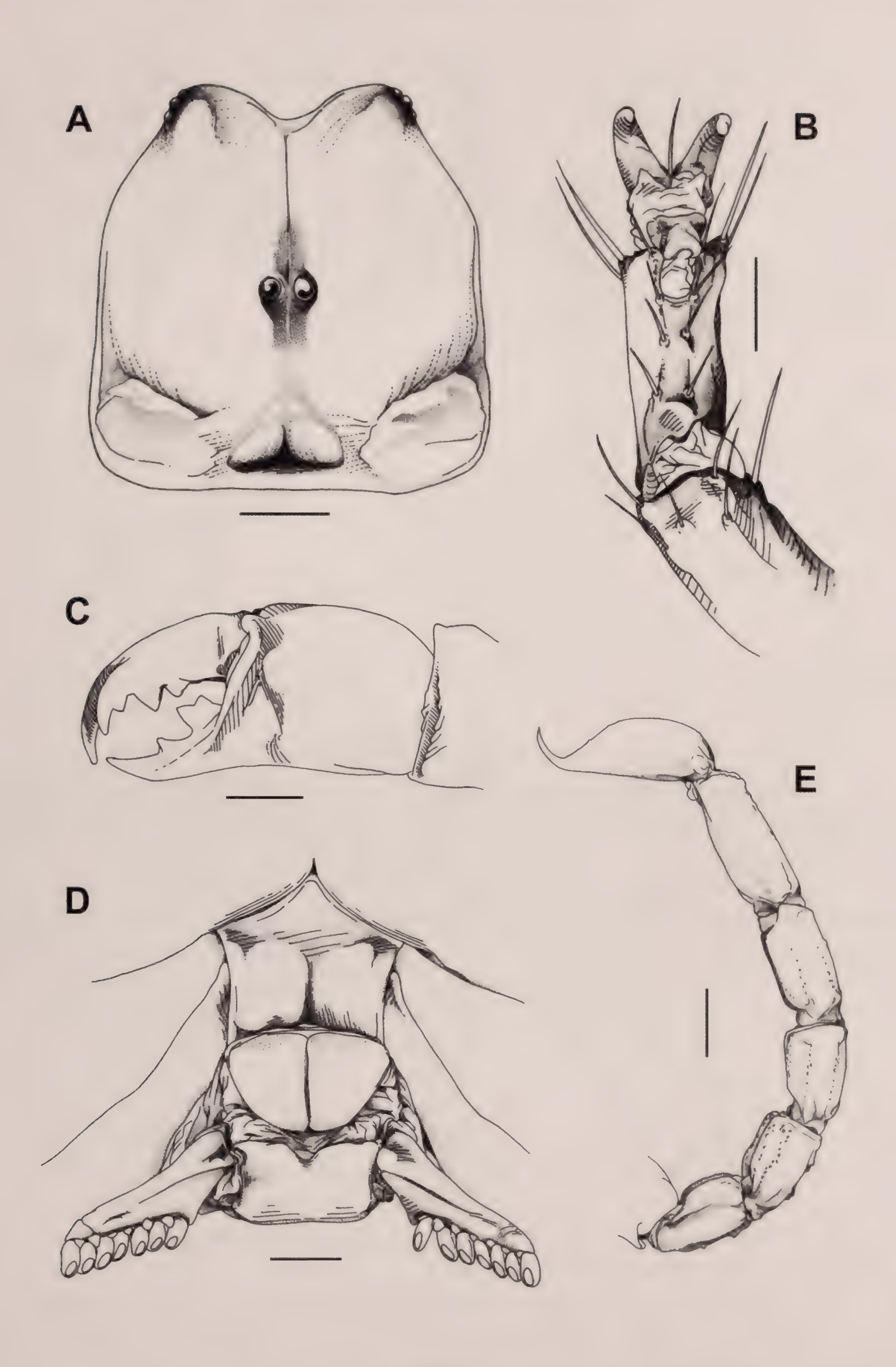


FIG. 1

Liocheles boholiensis Kraepelin, 1914, female holotype (ZMH). (A) Carapace, dorsal aspect. (B) Left tarsus IV, ventral aspect. (C) Left chelicera, dorsal aspect. (D) Pectines and genital opercula. (E) Metasoma, lateral aspect. Scale lines, 2 mm (A, E), 1 mm (C, D), 0.5 mm (B).

TABLE 1
Meristic data for the types of *Liocheles boholiensis* Kraepelin, 1914.

		Lectotype, female	Paralectotype, subadult female
Carapace	Length	8.8	6.7
	Anterior width	5.8	4.8
	Posterior width	9.6	7.6
Metasomal segment I	Length	3.2	2.2
	Width	2.0	1.5
Metasomal segment V	Length	4.5	3.6
	Width	1.6	1.0
	Height	1.6	1.2
Telson vesicle	Width	1.8	1.3
	Height	1.9	1.3
Pedipalp	Femur length	8.4	5.9
	Femur width	3.4	2.3
	Patella length	8.5	6.2
	Patella width	3.4	2.5
	Chela length	17.4	12.0
	Chela width	7.2	4.6
	Chela height	3.6	2.2
	Chela movable finger length	8.8	6.0
Total length		53.0	46.0

Pedipalp: Femur as long as or shorter than carapace. Chela virtually asetose.

Chela fingers morphosculpture: Denticulate edge even distally, with a double row of primary denticles often fused at the base, with inner accessory denticles (IAD), without enlarged granules. Chela fingers linear, without lobes and notches.

Trichobothriotaxy (Fig. 2): Chela manus without accessory trichobothria; *Dt* trichobothrium midpalm or slightly less than midpalm; four *V* trichobothria; V_3 and V_4 separate; *Esb* trichobothrium more distal than *Eb* group, close to *Est*; Eb_3 trichobothrium close to Eb_{1-2}; *Est* trichobothrium midpalm or nearly so. Chela fixed finger: *db* trichobothrium on dorsal surface; *esb*, *eb*, *est*, *et* equidistant (distance *est-esb* similar to distance *esb-eb*) or *est* closer to *esb*; *eb* trichobothrium at base of finger, behind point of articulation between fixed and movable fingers, in line with *esb-et* axis; *esb* trichobothrium in line with *est-et* axis, in proximal region of fixed finger; two *i* trichobothria. Patella: d_2 trichobothria distal to patellar spur; *et* series with three trichobothria; *est* series with one trichobothrium; *em* series with two trichobothria; *esb* series with two trichobothria; *em-esb* series with four trichobothria in a single group or in two groups esb_1 and esb_2/em_{1-2}; *eb* series with five trichobothria in two groups eb_1 and eb_{2-5} or eb_1/eb_{4-5} and eb_{2-3}; three *v* trichobothria.

Carinae: Chela manus: dorsal secondary carina obsolete; digital carina distinct, costate or granular, stronger than external secondary carina; external secondary carinae absent or obsolete; ventroexternal carina granular or crenulate; ventromedian and ventrointernal carinae absent or obsolete; internomedian carina present, granular (at least sparsely). Patella: prolateral process present (distinct), strongly developed, forming two distinct spiniform processes (bifid), these sometimes fused but not

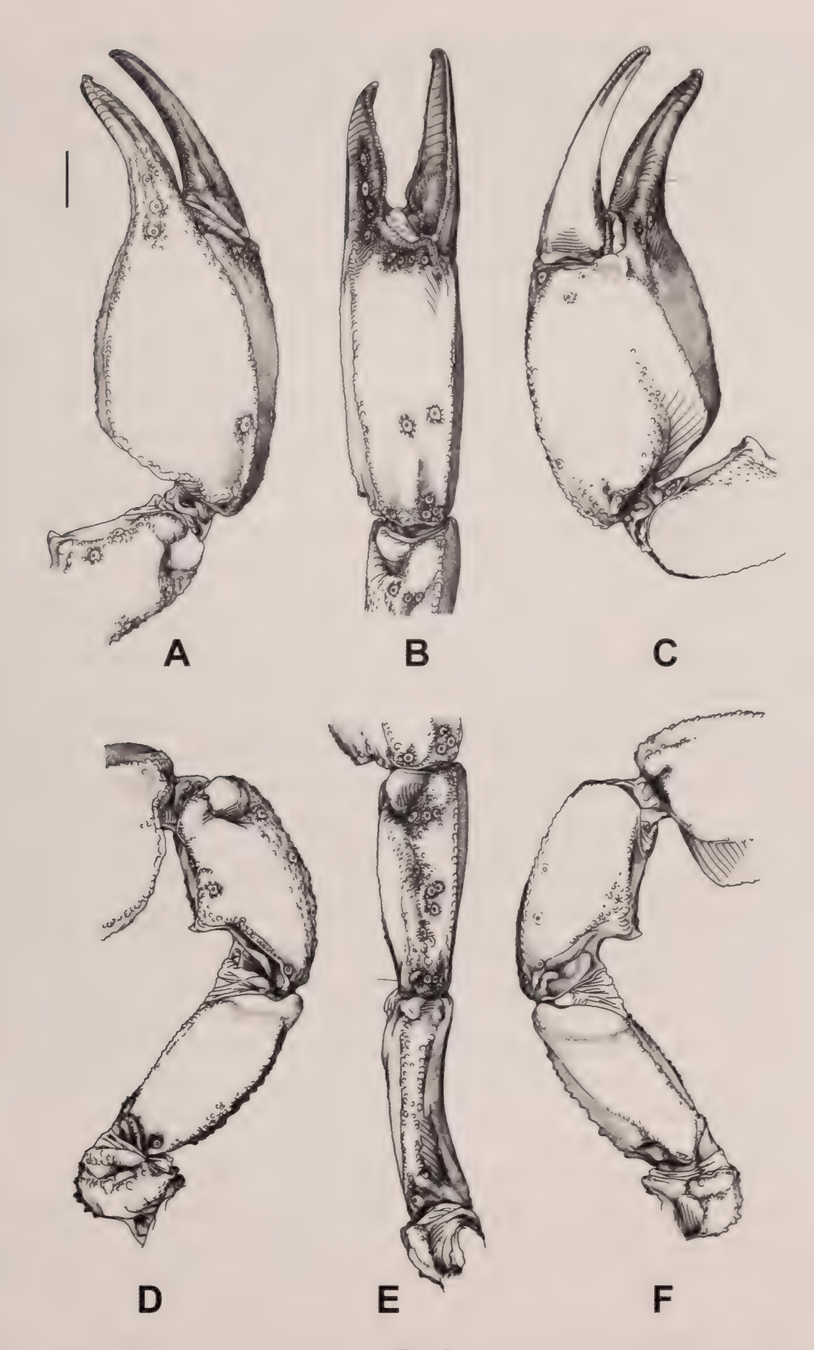


FIG. 2

Liocheles boholiensis Kraepelin, 1914, female holotype (ZMH), pedipalp with trichobothrial pattern. (A) Chela, dorsal aspect. (B) Idem, retrolateral aspect. (C) Idem, ventral aspect. (D) Trochanter, femur and patella, dorsal aspect. (E) Idem, retrolateral aspect. (F) Idem, ventral aspect. Scale line, 2 mm.

forming a large median spine; internodorsal and dorsomedian carinae distinct; dorsoexternal carina absent or obsolete; externomedian carinae granular or costate; ventroexternal carina present and distinct, costate or granular. Femur: dorsoexternal carina present and distinct, at least as a ridge, usually more distinct in proximal half, equally developed than dorsointernal carina; dorsointernal carina present and distinct; internomedian dorsal carina absent, without spines or granules (or with a single basal spine); internomedian ventral carina absent, without spines, or at most vestigial, with a single spine at proximal extremity; ventromedian carina absent or obsolete; ventrointernal carina present, granular.

Macrosculpture: Chela fingers granular (at least sparsely in proximal half). Chela fixed finger: area around *db/dsb/dst* trichobothria granular (at least in the most proximal part), *db/dsb/dst* trichobothria in a single large smooth depression. Chela: dorsal intercarinal surface entirely and densely granular, with medium-sized spiniform granules; retrolateral intercarinal surface granular; ventral intercarinal surface granular along prolateral and retrolateral edges only, smooth medially; prolateral intercarinal surface at least sparsely granular, granulation less distinct along prolateral ventral edge. Patella: dorsal and ventral intercarinal surfaces entirely granular, at least a reticulated network of granules present; retrolateral intercarinal surface at least sparsely granular; proximal half of prolateral intercarinal surface at least sparsely granular, distal half usually less granular. Femur: dorsal intercarinal surface densely granular except at distal end; dorsal and prolateral intercarinal surfaces with small to medium-sized spiniform granules; retrolateral dorsal intercarinal surface at least sparsely granular; retrolateral ventral intercarinal surface smooth or nearly so; ventral intercarinal surface smooth or with vestigial granulation limited to the retrolateral edge; prolateral intercarinal surface at least sparsely granular.

Carapace (Fig. 1A): Anterior margin with shallow median notch. Anterior furcated suture/sulcus present and distinct. Median ocular tubercle situated anteromedially, small, occupying about 1/9 of carapace width, at least slightly raised; superciliary carinae present, without granules. Median ocelli separated by at least half diameter of median ocellus, at least twice the size of lateral ocelli. Three pairs of lateral ocelli; ocelli equal in size, equidistant, close together, almost touching each other. Margin behind lateral ocellus without spines. Carapace surfaces with minute spiniform granules, evenly and sparsely distributed; anteromedian surface with frontal lobes smooth, granular along median longitudinal sulci and anterior furcated sulci; rest of carapace at least sparsely granular.

Mesosoma: Tergites I-VII with posterior margins straight or nearly so, without distinct prominence; posterior margins of pretergite smooth, without spines of granules; posttergite entirely smooth or nearly so. Posttergites III-VII with distinct reticulated network of ridges and dimples, surface uneven; I-VI with lateral transversal sulcus.

Ventral morphology: Anterodistal tip of coxa III without swelling or bulge. Sternum (Fig. 1D) equilateral pentagonal (anterior width slightly greater than posterior width); length less than or equal to posterior width. Genital operculum (Fig. 1D) oval to semi-oval, as wide as long (or wider than long), approximately same width as sternum; sclerites partly fused, median suture distinct; posterior notch present, at least

weakly developed. Pectines (Fig. 1D) short (distal edge not reaching distal edge of coxa of leg IV), with fulcrae and three marginal lamellae; six pectinal teeth, long, straight, covered with sensory papillae only in distal portion. Stigmata (spiracles) half-moon shaped (with a distinct curve), short (less than 1/3 of sternite width). Sternite VII without longitudinal carinae.

Metasoma (Fig. 1E) not flattened laterally. Segments I-IV with dorsomedian furrow shallow, weak to absent or only visible on segments I-III; dorsosubmedian carinae absent or obsolete; dorsolateral, ventrolateral and paired ventrosubmedian carinae present and distinct on at least some segments. Segment I: width less than or equal to height; median lateral carina present and distinct; dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventral surface without posterior spiniform granules; ventrosubmedian carinae with 1-2 pairs of moderate to strong subposterior spiniform granules and 1-3 pairs of well developed medial granules. Segment II: dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventrolateral carinae without posterior spiniform granules; ventrosubmedian carinae without posterior spiniform granules, with one pair of well developed subposterior spiniform granules and 1-3 pairs of well developed medial spiniform granules. Segment III: dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); ventrolateral carinae with ridges indistinct or weak and smooth; ventrosubmedian carinae with ridges indistinct or weak and smooth (sometimes with a few reduced spiniform granules), without subposterior spiniform granules. Segment IV: dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); ventrolateral carinae with no ridges visible or with weak smooth ridges; ventrosubmedian carinae with no ridges visible or with weak smooth ridges (sometimes with few reduced spiniform granules in posterior half), without subposterior spiniform granules. Segment V: dorsal surface smooth, without smooth shiny depression in posterior half between ventrolateral carinae; dorsolateral carinae absent or obsolete; ventrolateral carinae present and distinct, smooth or nearly so (rarely one pair of vestigial granules posteriorly); ventromedian carina absent or obsolete, ridges absent or weak and smooth; anal arch crenulate, at least with few reduced teeth. Telson as long as or slightly longer than metasomal segment V; vesicle smooth, without granules, unmodified.

Legs: Femora I-IV with ventromedian surfaces bicarinate (prolateral carinae often weakly developed). Femur IV with ventromedian carinae vestigial (only expressed distally) or indistinct (only scattered granules). Tibiae I-II: retrolateral margins without spiniform macrosetae. Basitarsus I: prolateral margin with 1-4 spiniform macrosetae; retrolateral margin with 1-5 spiniform macrosetae. Telotarsi I-IV (Fig. 1B): two ventrosubmedian rows of secondarily setiform macrosetae; ventromedian row of spinules absent or vestigial; basal spinules present (at least one, usually in a short row); terminal ventromedian spinules absent; ungues shorter than telotarsus. Telotarsi I-IV: prolateral/retrolateral rows with 3/4, 3/4, 3-4/4 and 4/4 spiniform macrosetae respectively.

Liocheles longimanus (Werner, 1939) stat. n. Figs 3-9, Table 2

Hormurus australasiae longimanus Werner, 1939: 362.
Liocheles australasiae longimanus: Locket, 1997: 331; Fet, 2000: 397; Monod & Volschenk, 2004: 686.
Liocheles longimanus: Monod, 2000: 97-101, pls 36-40, map 12.

DISTRIBUTION RANGE AND HABITAT: Indonesia, north-western Sumatra (FIG. 3). In humid tropical forests.

MATERIAL EXAMINED: ZMAK, alte Trockenpräparate 111; 1 ♂ syntype (here designated lectotype), 1 ♀ syntype (here designated paralectotype); Indonesia, Sumatra, Sumatera Utara Province, Montes Battak; H. Fruhstorfer. – MNHN, RS 3477; 2 ♀; Indonesia, Sumatra, Kenandam?; III.1913; Buxton?. – MNHN-RS 3471; 3 ♂, 5 ♀, 4 juv.; Indonesia, Sumatra, Kenandam?; 1913; Buxton?. – MHNG, Sum-06/11; 1 ♂; Indonesia, Sumatra, Sumatera Barat Province, Harau Canyon, N of Payakumbuh, 750 m, old secondary forest; 7.VI.2006; P. Schwendinger. – NNHM, without registration number; 1 ♂; Indonesia, Sumatra, Sumatera Barat Province, Lubuk Sikaping (Sumatra's Westkust), 450 m; 1926; E. Jacobson. – CAS, without registration number; 1 ♂, 1 ♀, 1 subadult ♂; Indonesia, Sumatra, Sumatera Barat Province, Mangani, mine near Kota Tinggi, 700 m; 21.VII.1983; E. S. Ross. – MNHN, RS 7417; 1 ♀, 1 juv.; Indonesia, Sumatra, Sumatera Barat Province, Ngalau Kamang Cave, near Bukittinggi; 20.VII.1979; J. Balazuc.

DIAGNOSIS: *L. longimanus* can be distinguished from *L. australasiae* by the following characters: (1) pectinal tooth count slightly higher (*L. longimanus*: 7-10 in males and 6-8 in females; *L. australasiae*: 6-7 males and 5-6 in females); (2) sexual dimorphism pronounced, pedipalps more elongated in males (femur longer than carapace); (3) ventral surface of pedipalp chela manus: *V3-V4* close together, in proximal part of manus; (4) prolateral process of pedipalp patella forming a single large spine; (5) patella: dorsal intercarinal surface smooth or nearly so, prolateral edge and proximal end weakly granular in some specimens; retrolateral ventral intercarinal surface smooth or nearly so; (6) femur: dorsal intercarinal surface with granulation absent or limited to proximal and retrolateral edges; retrolateral intercarinal surface smooth or nearly so; ventral intercarinal surface with granulation absent or vestigial and limited to retrolateral edge; (7) carapace entirely smooth or nearly so; (8) metasoma: dorsosubmedian carinae of segment II with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); ventrosubmedian carinae of segment I with medial granules weak to absent.

DESCRIPTION OF ADULT MALE (habitus see Figs 4, 5A, B): *Coloration*: As in figure 4. Pedipalps black to reddişh brown. Chelicerae: dorsal surface light brown to yellow; fingers slightly infuscated in some specimens. Carapace dark brown. Tergites dark brown, slightly lighter than carapace. Coxapophyses, sternum, genital operculum, pectines and sternites light brown to yellow. Metasoma dark brown, slightly lighter than carapace. Telson yellow. Legs light brown to yellow (paler than tergites).

Ornamentation of cuticle: Non-granular surfaces of mesosoma, metasoma, prosoma, legs and pedipalp finely punctated.

Chelicerae: Medial and basal teeth of fixed finger fused into a bicusp. Movable finger: dorsal margin with four teeth (one subdistal and one basal); distal dorsal tooth smaller than distal ventral tooth; ventral margin smooth.

Pedipalp: Femur slightly longer than carapace, Chela virtually asetose.

FIG. 3
Localities of *Liocheles longimanus* (Werner, 1939) on Sumatra.

Chela fingers morphosculpture: Denticulate edge even distally, with double row of primary denticles often fused at base, with inner accessory denticles (IAD), without enlarged granules. Chela movable finger: suprabasal lobe well developed, gently rounded dorsally and lacking a sharp conical tooth, wider than high, not overlapping fixed finger; suprabasal lobe and corresponding notch contiguous or at most with a reduced gap; basal lobe absent or at most 2-3 small spiniform granules present. Chela fixed finger: suprabasal notch distinct and deep; suprabasal lobe well developed and conical; basal lobe absent.

Trichobothriotaxy (Fig. 6): Chela manus without accessory trichobothria; *Dt* trichobothrium midpalm or slightly less than midpalm; four *V* trichobothria; V_3 and V_4 close together, in proximal part of manus; *Esb* trichobothrium basal, in same axis as *Eb* group; Eb_3 trichobothrium close to Eb_{1-2}; *Est* trichobothrium midpalm or nearly so. Chela fixed finger, *db* trichobothrium on dorsal surface; *esb*, *eb*, *est*, *et* equidistant (distance *est-esb* similar to distance *esb-eb*) or *est* closer to *esb*; *eb* trichobothrium at base of finger, behind point of articulation between fixed and movable fingers, above *esb-et* axis; *esb* trichobothrium below *est-et* axis, at base of finger, behind point of articulation between fixed and movable fingers; two *i* trichobothria. Patella: d_2 trichobothria distal to patellar spur; *et* series with three trichobothria; *est* series with one trichobothrium; *em* series with two trichobothria; *esb* series with two trichobothria; *em-esb* series with four trichobothria in two groups esb_{1-2} and em_{1-2}; *eb* series with five trichobothria in two groups eb_1 and eb_{2-5} or eb_1/eb_{4-5} and eb_{2-3}; three *v* trichobothria.

Carinae: Chela manus: dorsal secondary carina obsolete; digital carina distinct, costate or granular, stronger than external secondary carina; external secondary carinae

absent or obsolete; ventroexternal carina costate; ventromedian and ventrointernal carinae absent or obsolete; internomedian carina present, granular (at least sparsely or faintly). Patella: prolateral process present (distinct), strongly developed, forming a single large spine; internodorsal and dorsomedian carinae distinct; dorsoexternal carina absent or obsolete; externomedian carinae granular or costate; ventroexternal carina present and distinct, costate or granular. Femur: dorsoexternal carina present and distinct, at least as a ridge, usually more distinct in proximal half, less strongly developed than dorsointernal carina; dorsointernal carina present and distinct; internomedian dorsal carina absent, without spines or granules (or with a single basal spine); internomedian ventral carina vestigial, with two large spines (one proximal and one midway); internomedian carinae oriented parallel to dorsointernal and ventrointernal carinae; ventromedian carina absent or obsolete; ventrointernal carina present.

Macrosculpture: Chela fingers granular (at least sparsely in proximal half). Chela fixed finger: area around *db*/*dsb*/*dst* trichobothria smooth (trichobothria not in distinct depressions). Chela: dorsal intercarinal surface with vestigial granulation (at most low granules present) limited to prolateral and retrolateral edges, absent from median part; retrolateral intercarinal surface granular; ventral intercarinal surface without granules; prolateral intercarinal surface at least sparsely granular, granulation less distinct along prolateral ventral edge. Patella: dorsal intercarinal surface smooth or nearly so, prolateral edge and proximal end weakly granular in some specimens; ventral, retrolateral intercarinal surface smooth or nearly so; proximal half of prolateral intercarinal surface at least sparsely granular, distal half usually less granular. Femur: dorsal intercarinal surface with granulation absent or limited to proximal and retrolateral edges, when present, granulation dense; dorsal and prolateral intercarinal surfaces with small to medium-sized spiniform granules; retrolateral intercarinal surface smooth or nearly so; ventral intercarinal surface with granulation absent or vestigial and limited to retrolateral edge; prolateral intercarinal surface at least sparsely granular.

Carapace: Anterior margin with shallow median notch. Anterior furcated suture/sulcus present, distinct. Median ocular tubercle situated anteromedially, small, occupying about 1/9 of carapace width, at least slightly raised; superciliary carinae present, without granules. Median ocelli separated by at least half diameter of median ocellus, at least twice the size of lateral ocelli. Three pairs of lateral ocelli; ocelli equal in size, equidistant, close together, almost touching each other. Margin behind lateral ocellus without spines. Carapace entirely smooth or nearly so.

Mesosoma: Tergites I-VII with posterior margins straight or nearly so, without distinct prominence; posterior margin of pretergites smooth, without spines of granules. Posttergites I-VI smooth medially, lateral areas at least sparsely granular posteriorly; VII with anteromedian area smooth, lateral and posteromedian areas granular; granular areas of posttergites I-VII with minute spiniform granules, uniformly and sparsely distributed. Posttergites III-VII without reticulated network of ridges and dimples, surface even; I-VI with lateral transversal sulcus present.

Ventral morphology: Anterodistal tip of coxa III without swelling or bulge. Sternum (Fig. 7A) subpentagonal (anterior width approximately equal to or slightly less than posterior width); length less than or equal to posterior width. Pectines

FIG. 4

Liocheles longimanus (Werner, 1939). Male, dorsal aspect. Reconstruction based on scientific illustrations and photographs of live specimens. Scale line, 5 mm.

(Fig. 7A) moderately long (distal edge reaching, but not surpassing distal edge of coxa of leg IV), with fulcrae and three marginal lamellae; 7-10 pectinal teeth, long, straight, entirely covered by sensory papillae. Stigmata (spiracles) half-moon shaped (with a distinct curve), short (less than 1/3 of sternite width). Sternite VII without longitudinal carinae.

Metasoma (Fig. 8C): Segments I-V, length similar to or slightly longer than in female (Fig. 8D), not flattened laterally. Segments I-IV with median furrow shallow, weak to absent or only visible on segments I-III; dorsosubmedian and dorsolateral carinae absent or obsolete; ventrolateral and paired ventrosubmedian carinae present and distinct on at least some segments. Segment I: width less than or equal to height; median lateral carina present and distinct; dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventral surface with 1-2 pairs of well developed posterior spiniform granules; ventrosubmedian carinae with 1-2 pairs of moderate to strong subposterior spiniform granules, medial granules weak to absent. Segment II: dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventrolateral carinae with well developed posterior spiniform granules; ventrosubmedian carinae with 2-3 pairs of posterior, one pair of subposterior and 1-3 pairs of medial well developed spiniform granules. Segment III: dorsosubmedian carinae with posterior spiniform granules moderate to strong (distinctly larger than preceding granules); ventrolateral carinae with ridges indistinct or weak and smooth; ventrosubmedian carinae with ridges indistinct or weak and smooth (sometimes with a few reduced spiniform granules), without subposterior spiniform granules. Segment IV: dorsosubmedian carinae with posterior spiniform granules moderate to strong (distinctly larger than preceding granules); ventrolateral carinae with no ridges visible or with weak smooth ridges; ventrosubmedian carinae with no ridges visible or with weak smooth ridges (sometimes with few reduced spiniform granules in posterior half), without subposterior spiniform granules. Segment V: dorsal surface smooth, with smooth shiny depression in posterior half between ventrolateral carinae; dorsolateral carinae absent or obsolete; ventrolateral carinae present and distinct, anterior half smooth or nearly so, posterior half with strong conical tooth; ventromedian carina expressed only in posterior half, ridges absent or weak and smooth; anal arch crenulate, at least with few reduced teeth. Telson as long as or slightly longer than metasomal segment V; vesicle smooth, without granules, unmodified.

Legs: Femora I-IV with ventromedian surfaces bicarinate (prolateral carinae often weakly developed). Femur IV with ventromedian carinae vestigial (only expressed distally) or indistinct (only scattered granules). Tibiae I-II: retrolateral margins without spiniform macrosetae. Basitarsus I: prolateral margin with 1-4 spiniform macrosetae; retrolateral margin with 1-5 spiniform macrosetae. Telotarsi I-IV (Fig. 8B): two ventrosubmedian rows of secondarily setiform macrosetae; ventromedian row of spinules absent or vestigial; basal spinules absent; terminal ventromedian spinules absent; ungues shorter than telotarsus. Telotarsi I-IV: prolateral/retrolateral rows with 4/4, 4/4, 4/4 and 4/4 spiniform macrosetae respectively.

Hemispermatophore (Fig. 9): Distal lamina at least slightly curved, approximately same size as basal part or slightly longer; distal crest absent; single lamellar hook, basal (in basal 1/3 of distal lamella or below, at least less than mid-length); basal extrusion absent; transverse ridge present and distinct, merging with anterior edge above base of lamellar hook, at approximately same level as base of lamellar hook. Lamella thin, folded only proximally and unfolded to flattened distal extremity (tip and

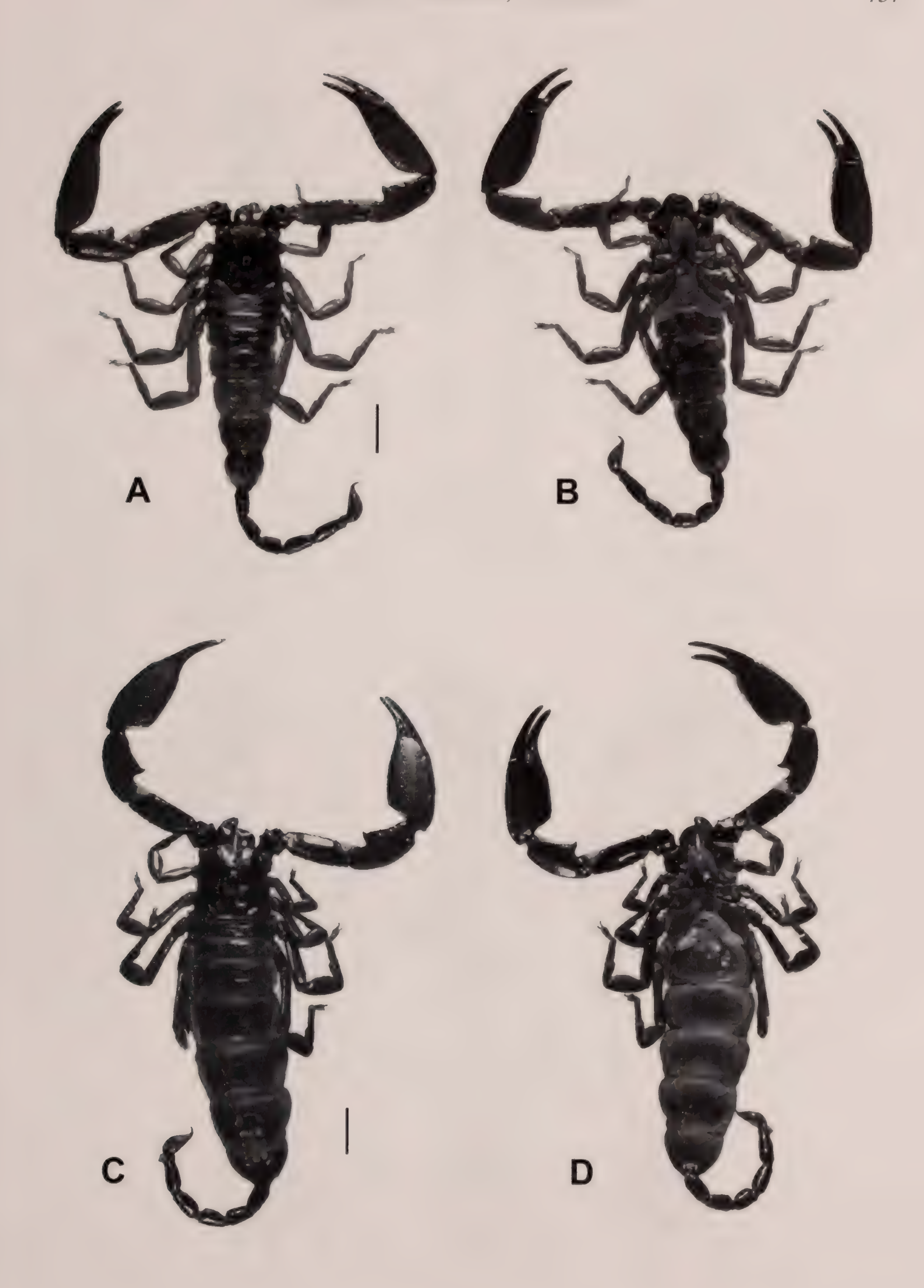


FIG. 5

Liocheles longimanus (Werner, 1939). (A) Male (MNHN-RS 3471), dorsal aspect. (B) Same, ventral aspect. (C) Female (MNHN-RS 3477), dorsal aspect. (D) Same, ventral aspect. Scale lines, 5 mm.

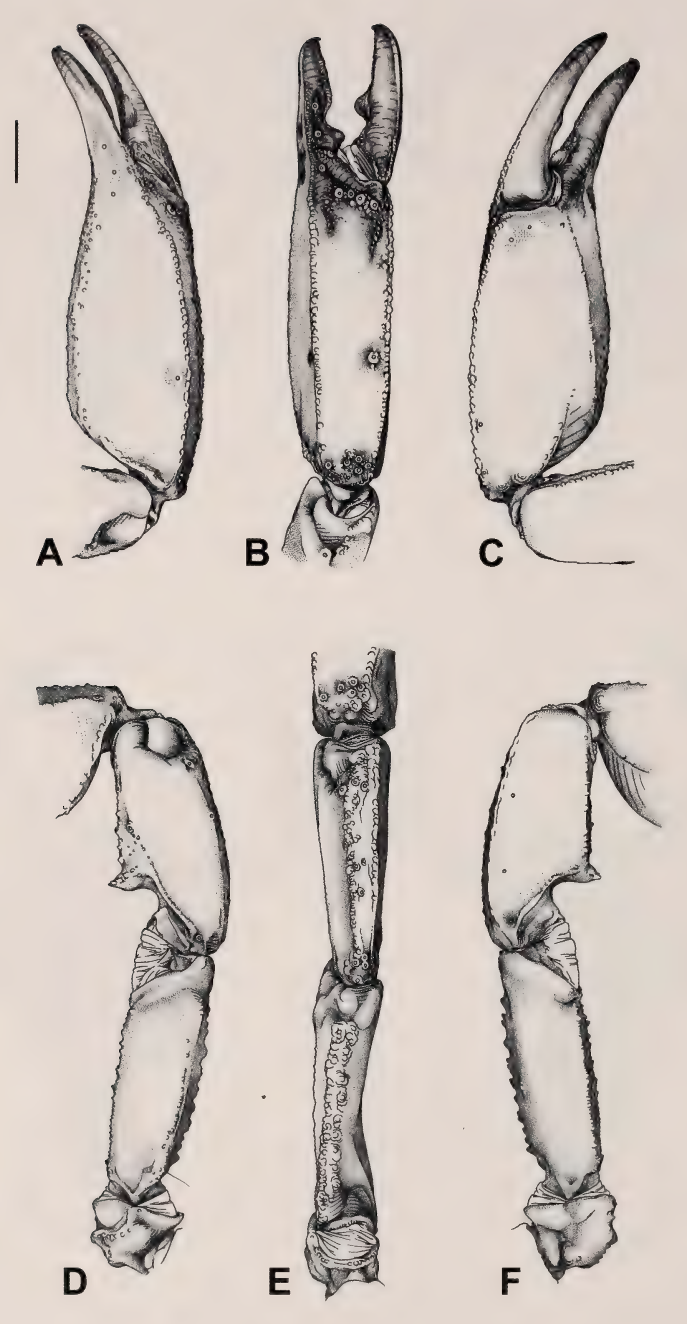


Fig. 6

Liocheles longimanus (Werner, 1939), male (MNHN-RS 3471), pedipalp with trichobothrial pattern. (A) Chela, dorsal aspect. (B) Idem, retrolateral aspect. (C) Idem, ventral aspect. (D) Trochanter, femur and patella, dorsal aspect. (E) Idem, retrolateral aspect. (F) Idem, ventral aspect. Scale line, 2 mm.

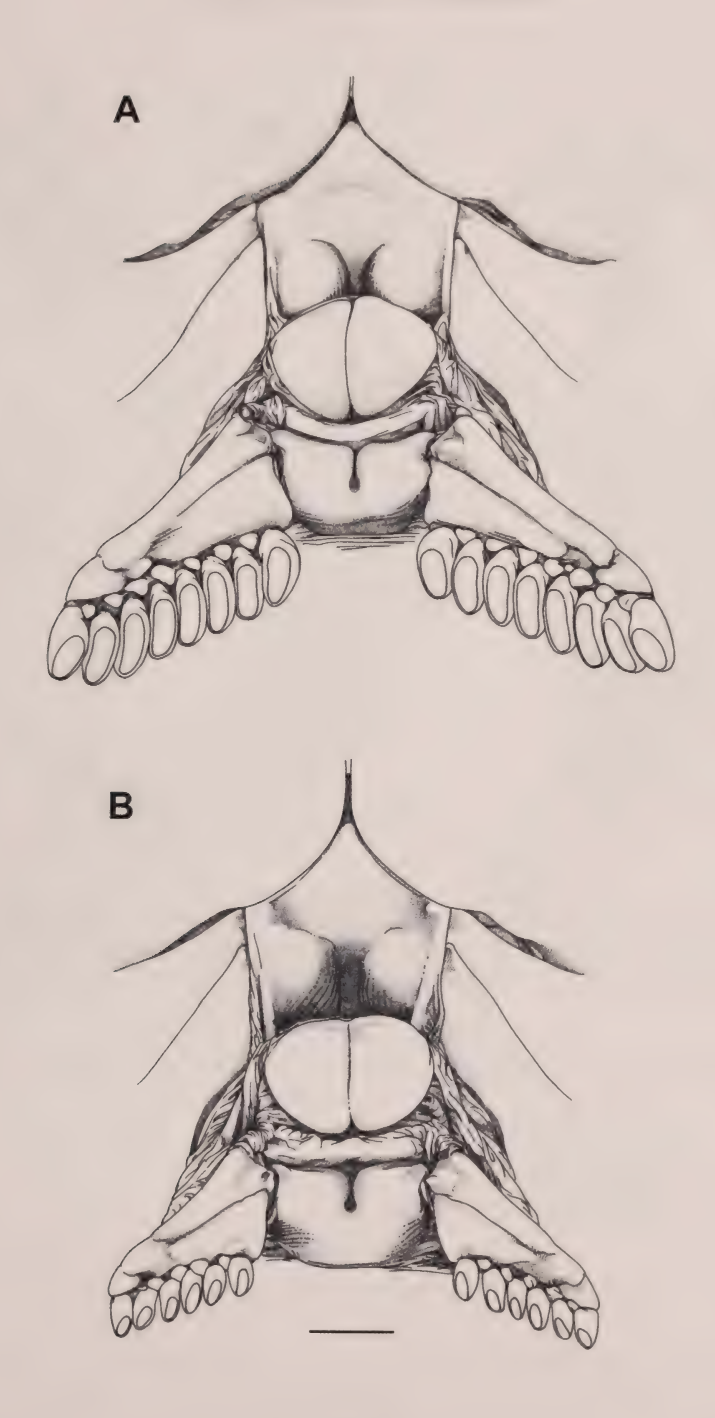


FIG. 7

Liocheles longimanus (Werner, 1939), pectines and genital opercula, ventral aspect. (A) Male (MNHN-RS 3471). (B) Female (MNHN-RS 3471). Scale line, 1 mm.

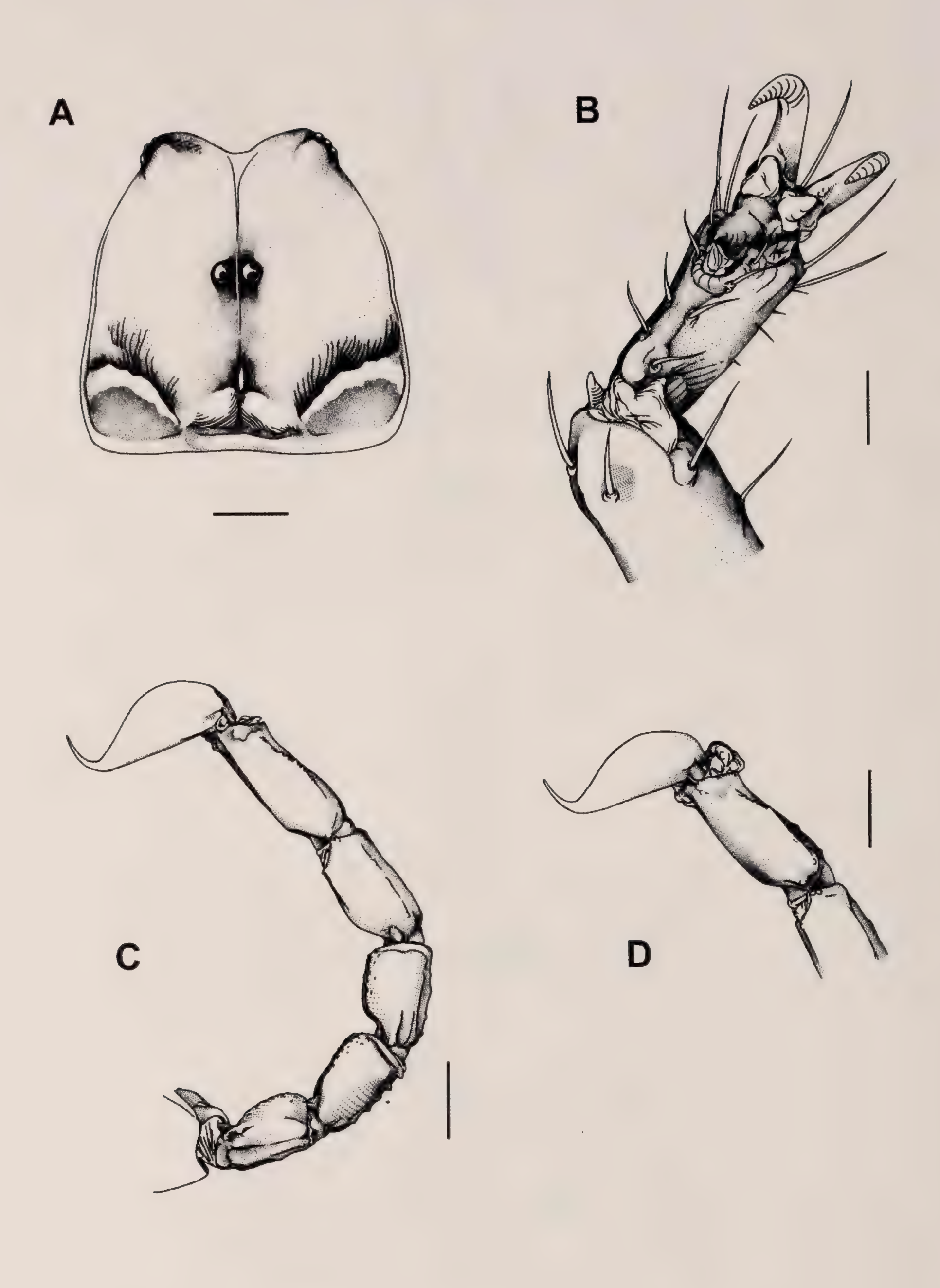


FIG. 8

Liocheles longimanus (Werner, 1939); male (MNHN-RS 3471) (A-C), female (MNHN-RS 3471) (D). (A) Carapace, dorsal aspect. (B) Right tarsus IV, ventral aspect. (C) Metasoma, lateral aspect. (D) Posterior part of metasoma, lateral aspect. Scale lines, 2 mm (A, C, D), 0.5 mm (B).

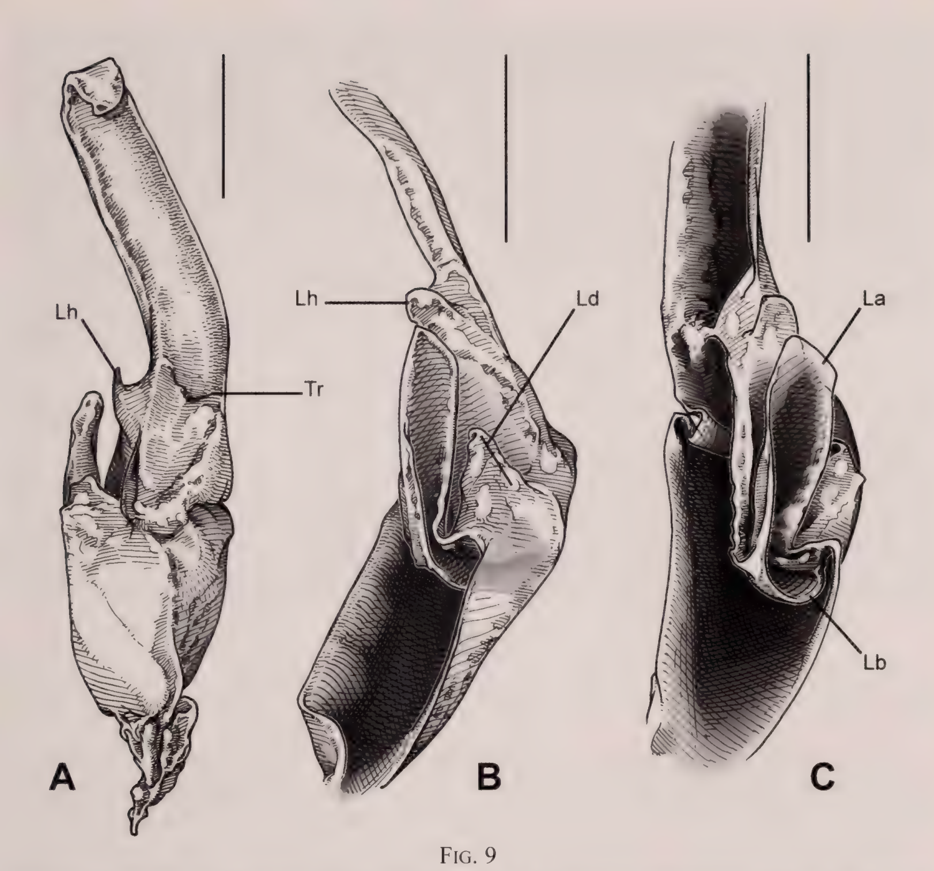


FIG. 9

Liocheles longimanus (Werner, 1939), male (CAS), left hemispermatophore. (A) In toto, dorsal aspect, Lh (lamellar hook), Tr (transverse ridge). (B) Detail of the capsular region, ental aspect, Ld (distal lobe), Ld (distal lobe). (C) Idem, ventral aspect, La (lamella), Lb (basal lobe). Scale lines, 1 mm.

base approximately of same width); longitudinal 'spine', accessory hook and accessory lobe absent; lamellar tip at approximately same level as base of lamellar hook, above tip of distal lobe. Distal lobe well developed as a distinct hump, without distinctive hook-like shape, without accessory hook, carinae or crest. Basal lobe well developed ('spoon' shaped), merging with accessory anterior basal lobe; distal edge without accessory fold toward ectal part, forming a 90° angle with lamella; basal edge without accessory fold (no groove), forming a 90° angle with lamella.

DESCRIPTION OF ADULT FEMALE (habitus see Fig. 5C, D): Same characters as in male except as follows.

Pedipalp markedly shorter and bulkier than in male (see Fig. 5). Denticulate edge of chela fingers linear or nearly so (without pronounced lobe and notch).

Mesosoma: Posttergites I-VII entirely smooth or nearly so.

Ventral Morphology: Genital operculum (Fig. 7B) oval to semi-oval, as wide as long (or wider than long), approximately same width as sternum; sclerites partly

TABLE 2
Meristic data for adult males and females of *Liocheles longimanus* (Werner, 1939).

		males			females		
Carapace	Length	6.8	6.4	6.5	8.2	7.2	6.9
	Anterior width	4.6	4.3	4.5	5.2	4.7	5.0
	Posterior width	7.5	7.2	7.2	9.0	7.5	7.5
Metasomal segment I	Length	2.7	2.6	2.7	2.8	2.8	2.7
	Width	1.7	1.6	1.6	2.1	1.8	1.7
Metasomal segment V	Length	4.2	4.2	4.1	4.3	3.9	4.0
	Width	1.2	1.2	1.3	1.6	1.3	1.3
	Height	1.5	1.5	1.5	1.7	1.5	1.4
Telson vesicle	Width	1.4	1.3	1.5	1.6	1.4	1.4
	Height	1.4	1.4	1.6	1.8	1.4	1.4
Pedipalps	Femur length	8.3	7.4	8.0	7.8	6.8	6.6
	Femur width	2.6	2.9	2.6	3.1	2.6	2.8
	Patella length	8.0	7.6	7.6	8.0	6.8	6.9
	Patella width	3.0	3.1	3.1	3.6	3.1	3.2
	Chela length	15.1	13.6	15.0	15.6	13.6	13.8
	Chela width	4.5	4.6	4.2	5.6	4.9	4.8
	Chela height	2.8	2.7	2.8	3.9	2.6	2.6
	Chela movable finger length	6.6	5.4	6.5	7.1	6.0	6.4
Total length		46	42	42	56	47	46

fusedmedian suture distinct; posterior notch present, at least weakly developed. Six to eight pectinal teeth (Fig. 7B), covered with sensory papillae only in distal portion.

INTRA-SPECIFIC VARIABILITY: As in other scorpions, the number of pectinal teeth varies: 7-10 in males and 6-8 in females.

Liocheles neocaledonicus (Simon, 1877) Figs 10-16, Table 3

Ischnurus neocaledonicus Simon, 1877: 237, 238.
Liocheles neocaledonico: Simon, 1887: 113 (misspelling of species name).
Hormurus caudicula: Kraepelin, 1894: 135 (part)(misidentification); Kraepelin, 1901: 272 (part)(misidentification).
Hormurus neocaledonicus: Kraepelin, 1914: 330, 332, 334, 335; Lampe, 1917: 201; Weidner, 1959: 101.
Hormurus sarasini Kraepelin, 1914: 332, 335, 336 (considered a subspecies of *Hormurus caudicula* by Giltay, 1931: 13); Weidner, 1959: 101; Forcart, 1961: 49 **syn. n.**
Hormurus caudicula neocaledonicus: Giltay, 1931: 13, 18, 19.
Hormurus caudicula sarasini: Giltay, 1931: 13, 18, 19.
Liocheles caudicula neocaledonicus: Takashima, 1945: 96.
Liocheles caudicula sarasini: Takashima, 1945: 96.
Liocheles waigiensis: L. E. Koch, 1977: 166-172, figs 18, 47, 82, 83, maps 9a, b (part)(misidentification); Kamenz & Prendini, 2008: 11, 43, pl. 134 (misidentification).
Liocheles neocaledonicus: Monod, 2000: 102-107, pls 41-45, map 13; Monod, 2005: 5.

FIG. 10
Localities of *Liocheles neocaledonicus* (Simon, 1877) on New Caledonia.

DISTRIBUTION RANGE AND HABITAT: Endemic to New Caledonia, widely distributed across the island (Fig. 10). In rocky habitats (scree slopes, boulders) of tropical humid forests.

TYPES: The male holotype of *Ischnurus neocaledonicus* Simon, 1877 could not be found in the collections of the MNHN, it is considered lost. – ZMH, without registration number; ♀ paratype of *Ischnurus neocaledonicus* (examined); New Caledonia; 20.VIII.1900; Bougier. – NMB, 56-a; ♂ lectotype of *Hormurus sarasini* Kraepelin, 1914 (designated by Forcart, 1961: 49) (not examined); New Caledonia, Tchalabel; V.1911; F. Sarasin & J. Roux. – NMB, 56-a; 6 ♂, 27 ♀ paralectotypes of *Hormurus sarasini* (not examined); same data as for lectotype. – ZMH, without registration number; 1 ♂, 5 ♀ and 1 juv. paralectotypes of *Hormurus sarasini* (examined), Tchalabel; II.1913; F. Sarasin.

OTHER MATERIAL: MNHN, VA 2660; 1 ♂, 1 ♀; without locality data; specimens examined by Vachon in 1981. – AMNH, Acc 37523; 1 ♂, 3 ♀, 9 juv.; New Caledonia; III-IV.1939; L. Macmillan. – BPBM, without registration number; 1 juv.; J. & M. Sedlacek. – MNHN, without registration number; 1 ♀; P. Rougeot. – MNHN, without registration number; 2 ♀; 14.I.1995, N. & B. Thibaud. – MNHN, RS 0474; 9 ♂, 11 ♀, 21 juv.; collection E. Simon. – MNHN, RS 0488; 1 juv.; Germain. – MNHN, RS 0530; 2 ♀; M. Bougier; collection Simon no.1998. – MNHN, RS 4424; 1 ♀, 1 juv.; M. Plessis. – MNHN, RS 8253; 1 ♀. – MRHN, without registration number; 1 ♀. – NHML, 1924.II.1.1; 1 ♀; 1914; P. D. Montague. – QM, S 17097; 1 ♂; 17.II.1977; B. Jamieson. – ZMH, without registration number; 1 ♀. – MNHN, RS 8537; 1 juv.; Bogui-Col des Rousettes, Station 26b, 270 m, mesic forest; 4.V.1987; A. Mordan & S. Tillier. – MNHN, RS 3240; 3 ♂, 1 ♀, 1 juv.; Bourail; 1902; H. Méray. – AMNH, without registration number; 1 juv.; Col des Rousettes, 490 m, dry forest; 29.V.1987; N. I. Platnick, R. J. Raven. – MNHN, RS 8537; 2 ♀, 2 juv.; Col des Rousettes, 500 m, mesic forest; 29.V.1987; S.

Tillier. – WAM, 98/1892; 1 ♀; Col des Rousettes, rainforest; 11.II.1993; M. S. Harvey, N. I. Platnick, R. J. Raven. – WAM 98/1891; 1 juv.; same data as WAM 98/1892. – LM, without registration number; 2 ♂, 3 ♀, 7 juv.; Col des Rousettes, track, 427 m, small patch of rainforest in between niaoulis savannah, in between stones in a scree covered by litter and tree roots, dryer habitat than previous specimens; 21.IX.2004; D. Gaillard, L. Monod. – AMNH, LP 5544; 1 juv.; Col des Rousettes, track, 427 m, small patch of rainforest in between niaoulis savannah, in between stones in a scree covered by litter and tree roots, dryer habitat than previous specimens; 21.IX.2004; D. Gaillard, L. Monod. – MNHN, RS 8537; 2 ♀, 13 juv.; Dothio, Col de Pétchékara, Station 287, 340 m, mesic forest; 27.X.1986; A. & S. Tillier. – LM, without registration number; 3 ♂, 4 ♀; Farino, Louis Barbou forest exploitation, 383 m, degraded humid forest, near dry creek, under stones; 7.X.2004; C. Mille, S. Cazeres & T. Nuques (I.A.C. Pocqueureux), L. Monod. – AMNH, LP 5547; 1 juv.; Farino, Louis Barbou forest exploitation, 383 m, degraded humid forest, near dry creek, under stones; 7.X.2004; C. Mille, S. Cazeres & T. Nuques (I.A.C. Pocqueureux), L. Monod. – LM, without registration number; 2 ♂, 3 ♀; Farino, Louis Barbou forest exploitation, 477 m, degraded humid forest, under stones; 7.X.2004; C. Mille, S. Cazeres & T. Nuques (I.A.C. Pocqueureux), L. Monod. – AMNH, LP 5548; 1 juv.; Farino, Louis Barbou forest exploitation, 477 m, degraded humid forest, under stones; 7.X.2004; C. Mille, S. Cazeres & T. Nuques (I.A.C. Pocqueureux), L. Monod. – QM, S 23332; 1 juv.; Forêt nord, sud de Noumea, Kwa Neie transmitter station, mixed-dry forest; 25.X.1988; T. C. (?) & R. Raven. – MNHN, RS 8349; 1 juv.; Goro, mesic forest; 3.IX.1975; P. Bouchet. – MNHN, RS 8537; 1 ♂, 1 juv.; S of Grand Lac, Station 235, 280 m, mesic forest on peridotites; 26.XI.84; A. & S. Tillier, P. Bouchet (MNHNP, Malacologie). – BPBM, Acc. No. 1979.380; 2 juv.; Hienghene, 10-50m; 14-17.VIII.1979; G. M. Nishida. – AMNH, AH 4622-4643; 3 ♂, 17 ♀, 2 juv.; Koyaboa Forest (Poindimié), NE central coast, 16/22.X.1983; Saint Louis (Noumea), on the banks of a creek; 16.XI.1979; A. Renévier. – WAM, 98/1887-8; 1 ♂, 1 juv.; Ile des Pins, near Grotte de la 3ème, rainforest; 19.III.1993; M. S. Harvey, N. I. Platnick, R. J. Raven. – MNHN, RS 7333; 2 ♀; La Foa; IX.1976; M. Droin. – MNHN, without registration number; 1♀; Grotte Le Cresson, 18.IX.65. – QM, S 39694; 2 ♀, 1 juv.; Chute de la Madeleine, 230 m; 12.XI.2000; P. Bouchard, C. Burwell & G. Monteith (9918). – NHML, 1927.II.1.2-5; 4 ♀; Mt Arago; P. D. Montague. – USNM, 00753; 1 ♀, 1 juv.; Mt Dor, 15 mi from Noumea; 22.X.1944; W. D. Crabb. – LM, without registration number; 3 ♂, 2 ♀; Mt Humbold, near mine, 505 m, degraded primary forest, vine thicket, in between stones in a scree covered by leaf litter and humus and under larger stones; 4.X.2004; L. Monod. – AMNH, LP 5546; 1 juv.; Mt Humbold, near mine, 505 m, degraded primary forest, vine thicket, in between stones in a scree covered by leaf litter and humus and under larger stones; 4.X.2004; L. Monod. – QM, without registration number; 1 ♀; Mt Koghis, 500 m, rainforest, night collecting; 2-3.XI.2002; Burwell, G. Monteith & S. Wright (11088). – LM, without registration number; 3 ♂, 3 ♀; Mt Koghis, start of tracks, 440 m, rainforest, under rocks; 26.IX.2004; D. Gaillard, L. Monod. – AMNH, LP 5545; 1 juv.; Mt Koghis, start of tracks, 440 m, rainforest, under rocks; 26.IX.2004; D. Gaillard, L. Monod. – AMNH, LP 6224; 2 juv.; Mt Koghis, ca. 20 km N Noumea; 4.XII.2004; S. Huber. – CAS, without registration number; 1 ♀, 2 juv.; S. E. slope of Mt Koyaboa (390 m), Poindimié, elevation less than 500 ft, 3.VI.1985, L. Wishmeyer. – MNHN, RS 8537; 1 ♀, 20 juv.; Mt Mé Ori, SE slope, Station 29 a, 530 m, forêt humide; 7.V.1987; A. Mordan & S. Tillier. – MNHN, without registration number; 1 ♂, 2 ♀, 1 juv.; Mt Pouédihi forest; 18.IV.1965. – MNHN, RS 8537; 1 juv.; Barrage de la Néaoua (Ouen Sieu), Station 210, 500 m, mesic forest; 20.XI.1984; A. & S. Tillier, P. Bouchet, M.-P. Triclot (MNHNP, Malacologie). – AMNH, LP 5542; 1 ♀; Road Nouméa-Rivière Bleue Forest Reserve, 177 m, vine thicket, in rock crevices; 17.IX.2004; D. Gaillard & L. Monod. – MNHN, RS 8350; 5 juv.; Oua Tom, 130 m, mesic forest; 16.IX.1978. – MNHN, RS 8537; 1 ♀, 2 juv.; Vallée de la Ouen Nondoué, Station 205, 70 m, Nothofagus forest; 20.X.1984; A. & S. Tillier, P. Bouchet, M.-P. Triclot (MNHNP, Malacologie). – NHM, 1924.II.1.6-7; 1 ♂, 1 ♀; Plaine des Lacs, forest, under bark; 23.II.1914; D. Montague. – MNHN, RS 8537; 1 ♂, 1 ♀, 2 juv.; Rivière Blanche, Parc Cagous, Station 256, 160/170 m, mesic forest; 1.IX.1986; A. & S. Tillier. – MNHN, without registration number; 1 ♂, 1 ♀, 6 juv.; Rivière Bleue Forest Reserve; 17.VIII.1965. – MNHN, without registration number; 3 juv.; Rivière Bleue Forest Reserve; 20.VIII.1965. – MNHN, without registration number; 2 juv.; Rivière Bleue Forest Reserve; 21.XI.1995; J. P. Hugot. – MNHN, without registration number; 1 ♂; Rivière Bleue Forest Reserve, under bark; 17.VII.1965; Stanniloner. – AMNH, without registration number; 1 juv.;

FIG. 11

Liocheles neocaledonicus (Simon, 1877). Male, dorsal aspect. Reconstruction based on scien - tific illustrations and photographs of live specimens. Scale line, 5 mm.

Rivière Bleue Forest Reserve, 280 m, wet forest; 21.V.1987; N. I. Platnick, R. J. Raven. – QM, S 23328; 3 ♀, 3 juv.; Rivière Bleue Forest Reserve, N rainforest; 21.V.1987; R. Raven. – WAM, 98/1885-6; 1 ♂, 1 ♀; Rivière Bleue Forest Reserve, 240 m, rainforest; 9.III.1993; M. S. Harvey, N. I. Platnick, R. J. Raven. – LM, without registration number; 3 ♂, 3 ♀; Rivière Bleue Forest Reserve, trail between Pont Pérignon and Kaori gèant, 116-169 m, rainforest, under stones and in rock crevices; 18.IX.2004; D. Gaillard, L. Monod. – AMNH, LP 5543; 1 juv.; Rivière Bleue

Forest Reserve, trail between Pont Pérignon and Kaori gèant, 116-169 m, rainforest, under stones and in rock crevices; 18.IX.2004; D. Gaillard, L. Monod. – AMNH, LP 4323; 2 juv.; Rivière Bleue Forest Reserve, Pic du Grand Kaori, 400 m, under dead wood branches; 11.V.2005; J. Murienne. – MNHN, RS 8537; 1 ♀, 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250, parcelle VI M, 160 m; 1.VIII.1986; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 a, parcelle VI H, 160 m; 15.IX.1986; Y. Letocart, A. & S. Tillier. – MNHN, RS 8537; 2 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 b, parcelle VI I, 160 m; 2.X.1987; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 d, parcelle VI I, 160 m; 4.XII.1987; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 e, parcelle VI J, 160 m; 5.I.1987; A. & S. Tillier. – MNHN, RS 8537; 1 ♂, 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 g, parcelle VI O, 160 m; 6.III.87; A. & S. Tillier. – MNHN, RS 8537; 1 ♀; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 h, parcelle VI O, 160 m; 6.IV.1987; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 i, parcelle VI W, 160 m; 30.V.1987; A. Mordan, A. & S. Tillier. – MNHN, RS 8537; 1 ♂; Rivière Bleue Forest Reserve, mesic forest/alluvia, station 250 j, parcelle VI G, 160 m; 12.VI.87; A. & S. Tillier. – MNHN, RS 8537; 2 ♂, 2 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251, parcelle VII V, 170 m; 15.VIII.1986; A. & S. Tillier. – MNHN, RS 8537; 2 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 a, parcelle VII U, 165 m; 22.IX.1987; A. & S. Tillier. – MNHN, RS 8537; 1 ♂, 1 ♀, 1 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 b, parcelle VII O, 170 m; 13.X.1986; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 d, parcelle VII U, 170 m; 11.XII.1986; A. & S. Tillier. – MNHN, RS 8537; 4 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 e, parcelle VII U, 170 m; 13.I.1987; A. & S. Tillier. – MNHN, RS 8537; 1 ♂, 2 ♀; Rivière Bleue Forest Reserve, mesic forest, station 251 f, parcelle VII L, 170 m; 12.II.1987; A. & S. Tillier. – MNHN, RS 8537; 1 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 g, parcelle VII K, 170 m; 16.III.1987; A. & S. Tillier. – MNHN, RS 8537; 1 ♂; Rivière Bleue Forest Reserve, mesic forest, station 251 h, parcelle VII R, 170 m; 14.IV.1987; A. & S. Tillier. – MNHN, RS 8537; 1 ♂, 1 ♀, 2 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 i, parcelle VII G, 170 m; 14.V.1987; A. Mordan, A. & S. Tillier. – MNHN, RS 8537; 1 ♂, 4 juv.; Rivière Bleue Forest Reserve, mesic forest, station 251 k, parcelle VII, 170 m; 16.VII.1986; A. & S. Tillier. – MNHN, RS 8537; 2 juv.; Rivière Bleue Forest Reserve, Station 255, Mt Kaala, S slope, dry - forest; 27.VIII.1986; A. Chazeau & S. Tillier. – QM, S 39696; 1 ♂, 2 juv.; Rivière Bleue Forest, Kaori géant; 11-12.XI.2000; P. Bouchard, C. Burwell & G. Monteith (9957). – QM, S 23331; 2 juv.; Rivière Bleue Reserve, near Kaori géant, 120 m; 25.V.1984; G. Monteith & D. Cook. – QM, S 39711; 1 ♀, 1 juv.; Rivière Bleue Forest Reserve, Panoramic track; 12.XI.2000; P. Bouchard, C. Burwell & G. Monteith (9951). – QM, without registration number; 1 ♂; Rivière Bleue Forest Reserve, Pic du Grand Kaori, 250 m; 16-18.XI.2002; S. Wright (11198). – QM, S 59098; 1 juv.; Rivière Bleue Forest Reserve, Pic du Grand Kaori, 250 m; 29.I.2002; G. B. Monteith (8922). – QM, S 23339; 1 ♀, 3 juv.; Rivière des Pirogues (headwaters), 350-400 m; 22.V.1984; G. Monteith & D. Cook. – MNHN, without registration number; 1 ♂, 1 juv.; Thi Forest Reserve; 5.VIII.65. – QM, S 23330; 1 ♀; Thi Forest Reserve, 150 m; 21.V.1984; G. Monteith & D. Cook. – AMNH, without registration number; 2 juv.; Touaourou, under stones; 20.X.1959; B. Malkin. – USNM, 00753; 1 ♀; Touaourou; 25.XII.1960; J. P. E. Morrison (3927, gto VI). – WAM, 98/1889-90; 1 ♀, 1 juv.; 2 km N of Troulala; 14.III.1993; M. S. Harvey, N. I. Platnick, R. J. Raven.

Diagnosis: *L. neocaledonicus* can be distinguished form *L. waigiensis* by the following characters: (1) femur as long as or shorter than carapace length; (2) male pedipalp chela: movable finger with basal lobe present as a low hump with 2-3 larger conical teeth; fixed finger with suprabasal lobe low/reduced; (3) prolateral process of pedipalp patella low, forming two distinct spiniform processes (bifid), these sometimes fused but not forming a large median spine; (4) prosoma with coarse spiniform granules at least on anteromedian surface, rest of prosoma usually with sparse smaller spiniform granules; (5) metasoma: dorsosubmedian carinae of segments III-IV with

FIG. 12

Liocheles neocaledonicus (Simon, 1877). (A) Male (MNHN-RS 8537, Rivière Bleue Forest Reserve), dorsal aspect. (B) Same, ventral aspect. (C) Female (MNHN-RS 8537, Rivière Bleue Forest Reserve), dorsal aspect. (D) Same, ventral aspect. Scale lines, 5 mm.

moderate to strong posterior spiniform granules (distinctly larger than preceding granules); ventrosubmedian carinae of segment I with 1-2 pairs of strong subposterior spiniform granules and 1-3 pairs of well developed medial granules; ventrosubmedian carinae of segment II with one pair of subposterior and 1-3 pairs of medial well deve-

loped spiniform granules; ventrosubmedian carinae of segment III with one pair of well developed subposterior spiniform granules.

DESCRIPTION OF ADULT MALE (habitus see Figs 11, 12A, B): *Coloration*: As in figure 11. Pedipalps black to reddish brown. Chelicerae: dorsal surface light brown to orange, fingers slightly infuscated. Carapace black to dark brown. Tergites black to dark brown, slightly lighter than carapace. Coxapophyses, sternum, genital operculum, pectines and sternites light brown to orange. Metasoma black to dark brown. Telson light brown to orange (paler than metasoma). Legs light brown to orange (paler than tergites).

Ornamentation of cuticle: Non-granular surfaces of mesosoma, metasoma, prosoma, legs and pedipalp finely punctated.

Chelicerae: Medial and basal teeth of fixed finger fused into a bicusp. Movable finger: dorsal margin with four teeth (one subdistal and one basal); distal dorsal tooth smaller than distal ventral tooth; ventral margin smooth.

Pedipalp: Femur as long as or shorter than carapace. Chela virtually asetose.

Chela fingers morphosculpture: Denticulate edge even distally, with double row of primary denticles often fused at base, with inner accessory denticles (IAD), without enlarged granules. Chela movable finger: suprabasal lobe well developed, gently rounded dorsally and lacking a sharp conical tooth, wider than high, not overlapping fixed finger; suprabasal lobe and corresponding notch contiguous or at most with a reduced gap; basal lobe reduced to low hump, with 2-3 larger conical teeth. Chela fixed finger: suprabasal notch distinct and deep; suprabasal lobe present and distinct, low and reduced; basal lobe absent.

Trichobothriotaxy (Fig. 13): Chela manus without accessory trichobothria; *Dt* trichobothrium midpalm or slightly less than midpalm; four *V* trichobothria; V_3 and V_4 separate; *Esb* trichobothrium more distal than *Eb* group, midway between *Eb* group and *Est*; Eb_3 trichobothrium close to Eb_{1-2}; *Est* trichobothrium midpalm or nearly so. Chela fixed finger, *db* trichobothrium on dorsal surface; *esb*, *eb*, *est*, *et* equidistant (distance *est-esb* similar to distance *esb-eb*) or *est* closer to *esb*; *eb* trichobothrium at base of finger, behind point of articulation between fixed and movable fingers, above *esb-et* axis; *esb* trichobothrium below *est-et* axis, at base of finger, behind point of articulation between fixed and movable fingers; two *i* trichobothria. Patella: d_2 trichobothria distal to patellar spur; *et* series with three trichobothria; *est* series with one trichobothrium; *em* series with two trichobothria; *esb* series with two trichobothria; *em-esb* series with four trichobothria in two groups esb_{1-2} and em_{1-2}; *eb* series with five trichobothria in two groups eb_1 and eb_{2-5} or eb_1/eb_{4-5} and eb_{2-3}; three *v* tricho - bothria.

Carinae: Chela manus: dorsal secondary carina obsolete; digital carina distinct, costate or granular, stronger than external secondary carina; external secondary carinae absent or obsolete; ventroexternal carina granular or crenulate; ventromedian and ventrointernal carinae absent or obsolete; internomedian carina present, granular (at least sparsely or faintly). Patella: prolateral process present (distinct), low, forming two distinct spiniform processes (bifid), these sometimes fused but not forming a large median spine; internodorsal and dorsomedian carinae distinct; dorsoexternal carina

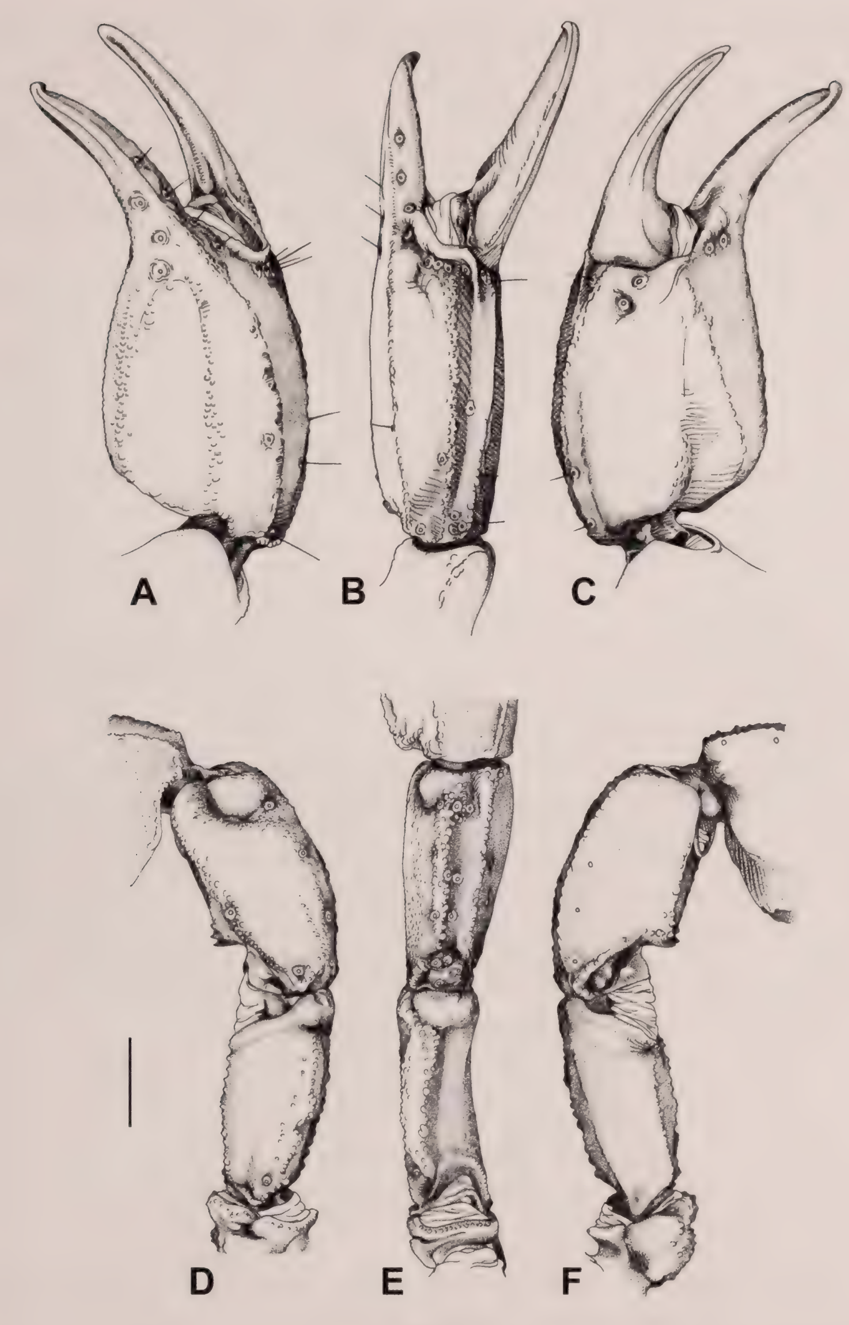


FIG. 13

Liocheles neocaledonicus (Simon, 1877), female paratype (ZMH), pedipalp with trichobothrial pattern. (A) Chela, dorsal aspect. (B) Idem, retrolateral aspect. (C) Idem, ventral aspect. (D) Trochanter, femur and patella, dorsal aspect. (E) Idem, retrolateral aspect. (F) Idem, ventral aspect. Scale line, 2.5 mm.

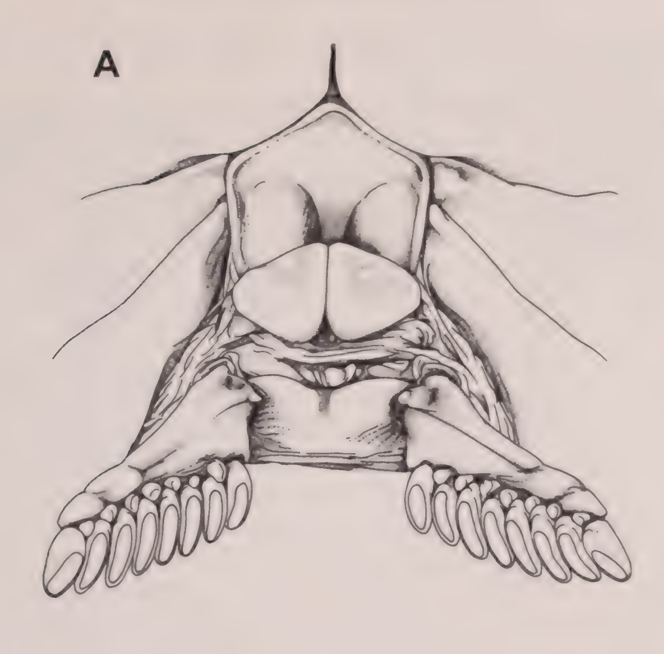
absent or obsolete; externomedian carinae granular or costate; ventroexternal carina present and distinct, costate or granular. Femur: dorsoexternal carina present and distinct, at least as a ridge, usually more distinct in proximal half, equally developed than dorsointernal carina; dorsointernal carina present and distinct; internomedian dorsal carina absent, without spines or granules (or with a single basal spine); internomedian ventral carina absent, without spines, or at most vestigial, with a single spine at proximal extremity; ventromedian carina absent or obsolete; ventrointernal carina present, granular.

Macrosculpture: Chela fingers granular (at least sparsely in proximal half). Chela fixed finger: area around *db*/*dsb*/*dst* trichobothria granular (at least in the most proximal part), *db*/*dsb*/*dst* trichobothria in three distinct smooth depressions (one around each trichobothrium). Chela: dorsal intercarinal surface entirely and densely granular, with medium-sized spiniform granules; retrolateral intercarinal surface granular; ventral intercarinal surface with granulation present along prolateral and retrolateral edges only, smooth medially; prolateral intercarinal surface at least sparsely granular, granulation less distinct along prolateral ventral edge. Patella: dorsal and ventral intercarinal surfaces entirely granular, at least a reticulated network of granules present; retrolateral intercarinal surface at least sparsely granular; prolateral intercarinal surface: proximal half at least sparsely granular, distal half usually less granular. Femur: dorsal intercarinal surface densely granular except for distal end; dorsal and prolateral intercarinal surfaces with small to medium-sized spiniform granules; retrolateral and prolateral intercarinal surfaces at least sparsely granular; ventral intercarinal surface granular proximally, distal part without granulation.

Carapace: Anterior margin with shallow median notch. Anterior furcated suture/sulcus present and distinct. Median ocular tubercle situated anteromedially, medium-sized, occupying about 1/7 of carapace width, at least slightly raised; superciliary carinae present, with at least few granules. Median ocelli separated by at least half diameter of median ocellus, at least twice the size of lateral ocelli. Three pairs of lateral ocelli; ocelli of equal size, equidistant, close together, almost touching each other. Margin behind lateral ocellus without spines. Carapace entirely granular, at least sparsely; large spiniform granules on anteromedian surface, rest of prosoma usually with smaller spiniform granules, evenly and sparsely distributed.

Mesosoma: Tergites I-VII with posterior margins straight or nearly so, without distinct prominence; posterior margin of pretergites smooth, without spines of granules. Posttergites I-VII, with minute spiniform granules, uniformly and sparsely distributed; I-VI entirely granular, at least sparsely in posterior half, granulation absent or vestigial on ridges in some specimens; VII entirely granular, at least sparsely. Posttergites III-VII with distinct reticulated network of ridges and dimples, surface uneven; I-VI with lateral transversal sulcus.

Ventral morphology: Anterodistal tip of coxa III without swelling or bulge. Sternum (Fig. 14A) subpentagonal (anterior width approximately equal to or slightly less than posterior width); length less than or equal to posterior width. Pectines (Fig. 14A) moderately long (distal edge reaching, but not surpassing distal edge of coxa of leg IV), with fulcrae and three marginal lamellae; 7-12 pectinal teeth, long, straight, entirely covered by sensory papillae. Stigmata (spiracles) half-moon shaped



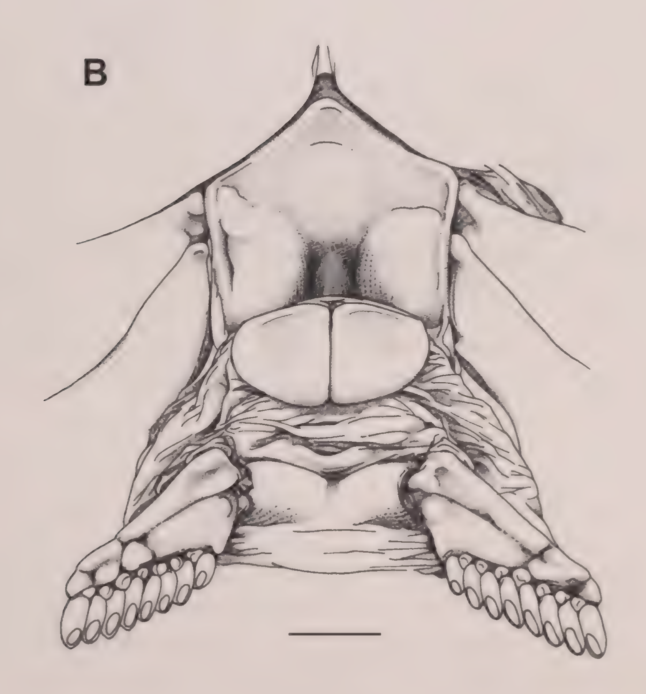


FIG. 14

Liocheles neocaledonicus (Simon, 1877), pectines and genital opercula, ventral aspect. (A) Male (*H. sarasini* paralectotype, ZMH). (B) Female (*H. sarasini* paralectotype, ZMH). Scale line, 1 mm.

(with a distinct curve), short (less than 1/3 of sternite width). Sternite VII without longitudinal carinae.

Metasoma (Fig. 15C): Segments I-V as long as or slightly longer than in female (Fig. 15D), not flattened laterally. Segments I-IV with dorsomedian furrow shallow, weak to absent or only visible on segments I-III; dorsosubmedian and dorsolateral carinae absent or obsolete; ventrolateral and paired ventrosubmedian carinae present and distinct on at least some segments. Segment I: width less than or equal to height; median lateral carina present and distinct; dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventral surface without posterior spiniform granules; ventrosubmedian carinae with 1-2 pairs of moderate to strong subposterior spiniform granules and 1-3 pairs of well developed medial granules. Segment II: dorsosubmedian carinae with posterior spiniform granules weak to absent (not noticeably larger than preceding granules); dorsomedian posterior spiniform granules weak to absent; ventrolateral carinae without posterior spiniform granules; ventrosubmedian carinae without posterior spiniform granules, with one pair of subposterior and 1-3 pairs of medial well developed spiniform granules. Segment III: dorsosubmedian carinae with posterior spiniform granules moderate to strong (distinctly larger than preceding granules); ventrolateral carinae with ridges indistinct or weak and smooth; ventrosubmedian carinae with ridges indistinct or weak and smooth (sometimes with a few reduced spiniform granules), with one pair of well developed subposterior spiniform granules. Segment IV: dorsosubmedian carinae with posterior spiniform granules moderate to strong (distinctly larger than preceding granules); ventrosubmedian carinae with ridges indistinct or weak and smooth (sometimes with few reduced spiniform granules in posterior half), without subposterior spiniform granules; ventrolateral carinae with ridges indistinct or weak and smooth. Segment V: dorsal surface smooth, without smooth shiny depression in posterior half between ventrolateral carinae; dorsolateral carinae absent or obsolete; ventromedian carina absent or obsolete, ridges absent or weak and smooth; ventrolateral carinae present and distinct, smooth or nearly so (rarely one pair of vestigial granules posteriorly); anal arch crenulate, at least with few reduced teeth. Telson as long as or slightly longer than metasomal segment V; vesicle smooth, without granules, unmodified.

Legs: Femora I-IV with ventromedian surfaces bicarinate (prolateral carinae often weakly developed). Femur IV with ventromedian carinae vestigial (only expressed distally) or indistinct (only scattered granules). Tibiae I-II: retrolateral margins without spiniform macrosetae. Basitarsus I: prolateral margin with 1-4 spiniform macrosetae; retrolateral margin with 1-5 spiniform macrosetae. Telotarsi I-IV (Fig. 15B): two ventrosubmedian rows of secondarily setiform macrosetae; ventromedian row of spinules absent or vestigial; basal spinules present (at least one, usually in a short row); terminal ventromedian spinules absent; ungues shorter than telotarsus. Telotarsi I-IV: prolateral/retrolateral rows with 4/4, 4/4, 5/5 and 5/5 spiniform macrosetae respectively.

Hemispermatophore (Fig. 16): Distal lamina at least slightly curved, approximately of same size as basal part or slightly longer; distal crest absent; single lamellar

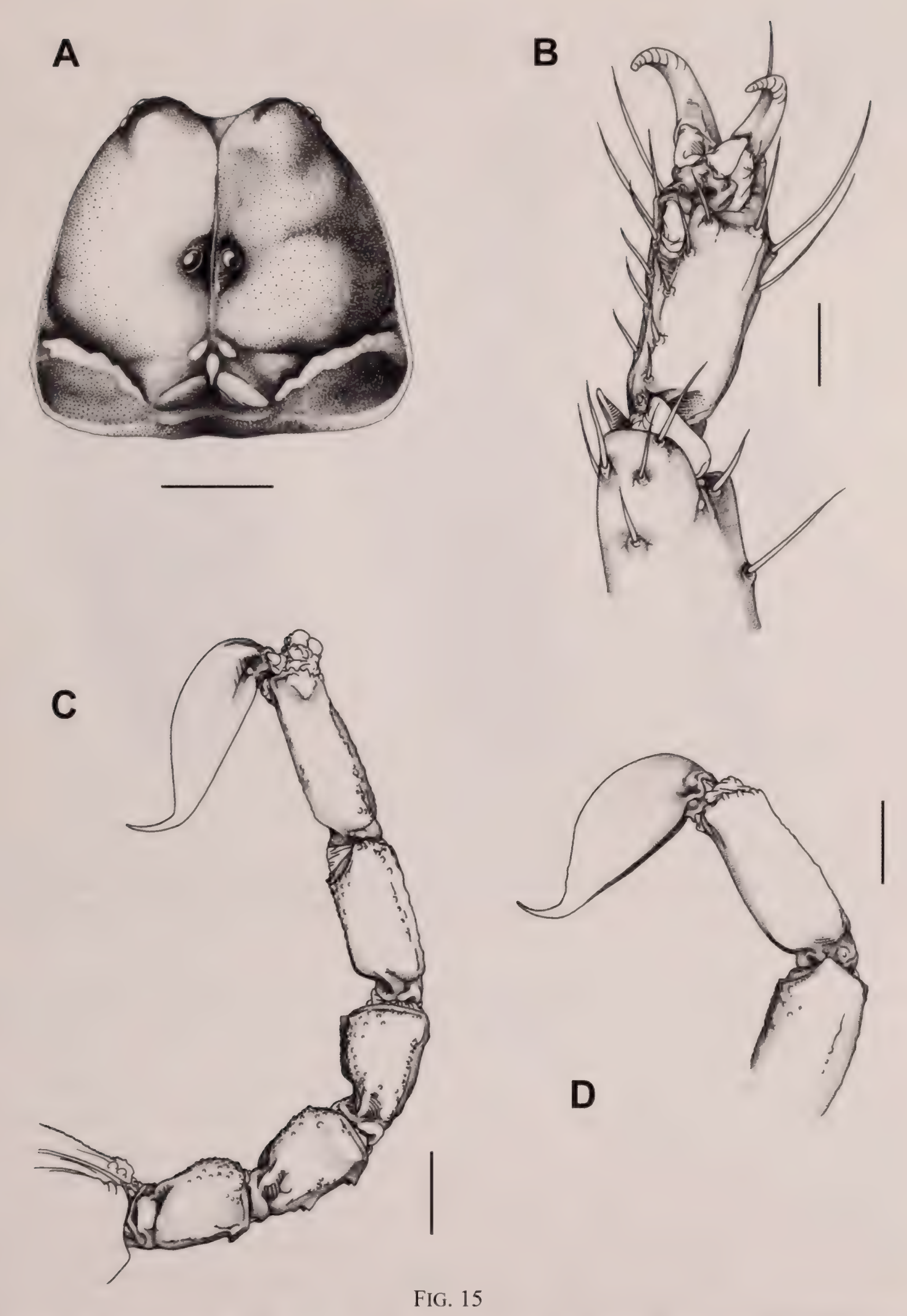


FIG. 15

Liocheles neocaledonicus (Simon, 1877). (A) Carapace of female paratype (ZMH), dorsal aspect. (B) Left tarsus IV of male (*H. sarasini* paralectotype, ZMH), ventral aspect. (C) Metasoma of male (*H. sarasini* paralectotype, ZMH), lateral aspect. (D) Metasoma of female paratype (ZMH), lateral aspect. Scale lines, 2.5 mm (A), 2 mm (C, D), 0.5 mm (B).

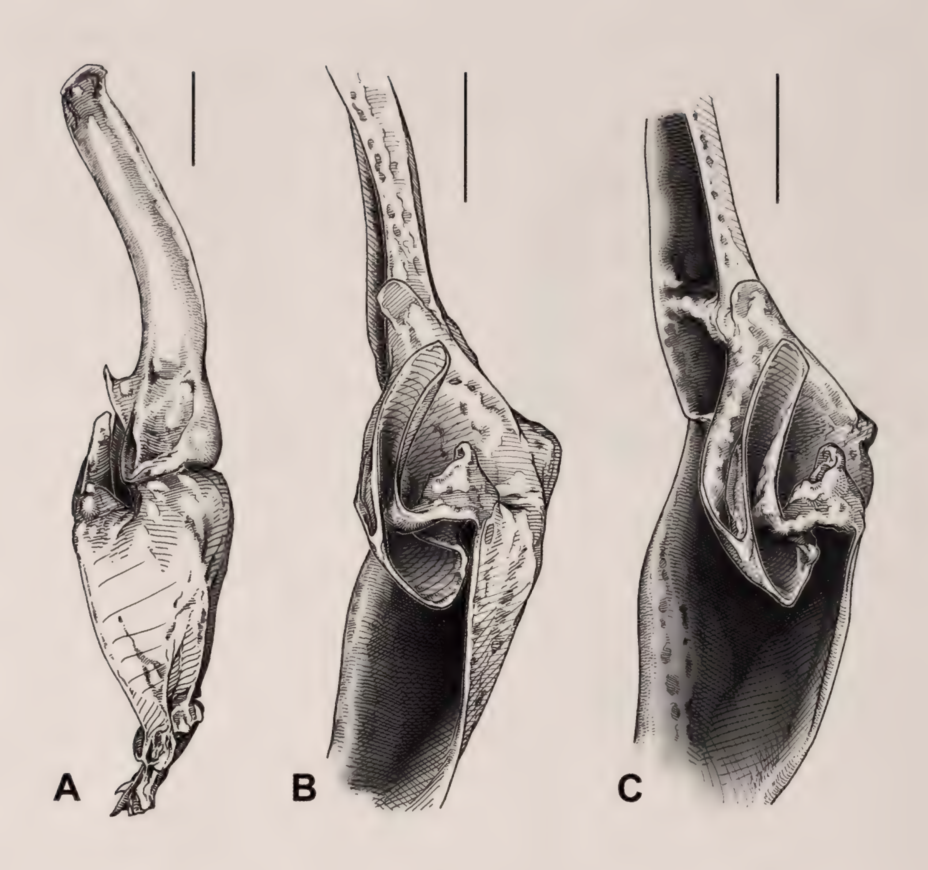


FIG. 16

Liocheles neocaledonicus (Simon, 1877), male (LM, Mount Koghis), left hemispermatophore. (A) In toto, dorsal aspect. (B) Detail of capsular region, ental aspect. (C) Idem, ventral aspect. Scale lines, 1 mm.

hook in basal 1/3 of distal lamella or below; basal extrusion absent; transverse ridge present and distinct, merging with anterior edge above base of lamellar hook, at approximately same level as base of lamellar hook. Lamella thin, folded only proximally and unfolded towards flattened distal extremity (tip and base approximately of same width); longitudinal 'spine', accessory hook and accessory lobe absent; lamellar tip below base of lamellar hook and above tip of distal lobe. Distal lobe well developed as a distinct hump, without distinctive hook-like shape, without accessory hook, carinae or crest. Basal lobe well developed (spoon shaped), merging with accessory anterior basal lobe; distal edge without accessory fold toward ectal part, forming a 90° angle with lamella; basal edge without accessory fold (no groove), forming a 135-150° angle with lamella.

Book lungs (after Kamenz & Prendini, 2008): Lamellar surface with simple trabeculae. Lamellar distal edges with arcuate bow-like structures. Posterior spiracle edge with chisel-like structures.

TABLE 3

Meristic data for adult males and females of Liocheles neocaledonicus (Simon, 1877).

		males			females		
Carapace	Length	7.2	6.2	6.9	7.8	6.4	8.6
	Anterior width	4.2	3.8	4.8	4.7	3.9	5.4
	Posterior width	8.6	7.4	8.0	9.4	7.7	9.3
Metasomal segment I	Length	2.7	2.3	2.4	2.4	2.1	2.5
	Width	2.1	1.9	1.9	2.1	1.9	2.3
Metasomal segment V	Length	4.5	4.2	4.4	4.4	3.6	4.8
	Width	1.5	1.2	1.4	1.7	1.3	1.8
	Height	1.6	1.4	1.5	1.8	1.4	1.8
Telson vesicle	Width	1.6	1.3	1.5	1.8	1.3	1.7
	Height	1.7	1.4	1.6	1.8	1.4	1.8
Pedipalps	Femur length	6.5	5.6	6.5	6.6	5.2	7.4
	Femur width	3.0	2.6	2.9	3.2	2.5	3.4
	Patella length	6.8	5.9	6.8	7.4	5.6	8.1
	Patella width	3.2	2.7	3.4	3.4	2.6	4.2
	Chela length	14.9	12.8	14.3	15.4	12.0	16.9
	Chela width	5.8	4.8	5.3	6.2	4.7	6.4
	Chela height	3.5	2.6	3.3	3.5	2.5	4.2
	Chela movable finger length	7.7	6.7	7.5	7.9	6.2	9.1
Total length		49	40	44	51	42	58

DESCRIPTION OF ADULT FEMALE: Same characters as in male except as follows.

Pedipalp: Chela fingers linear or nearly so, without lobes and notches.

Ventral morphology (Fig. 14B): Genital operculum oval to semi-oval, as wide as long (or wider than long), approximately same width as sternum; sclerites partly fused, median suture distinct; posterior notch weakly developed. Pectines short (distal edge not reaching distal edge of coxa of leg IV). Six to eleven pectinal teeth covered with sensory papillae only in distal portion.

INTRA-SPECIFIC VARIABILITY: In males the lobe on the cutting edge of the movable finger and the corresponding notch on the fixed finger of the pedipalp chela can be more or less developed. Some specimens display very low lobes, while others have more pronounced lobes. Moreover, the fitting between the lobe and the notch is also variable; in most specimens there is no gap between them, or at most a very narrow posterior gap. However, some males have slighty larger posterior gaps. Bigger specimens tend to have a more pronounced lobe and notch, and usually also display larger posterior gaps. The posterior spiniform granules on the dorsosubmedian carinae of metasomal segments III and IV are usually distinctly larger than the preceding granules, however there is no clear size difference in some specimens. Pectinal teeth count variation is as follow: 7-12 in males and 6-11 in females.

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